

**PM_{2.5}, NO_x AND CO
EMISSIONS FROM THE
DARBY SCHOOL
MESSERSMITH HURST
STEAM BOILER
DARBY, MONTANA**

Test Dates: February 13-14, 2008

Prepared for:
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Revised Report Date:
April 25, 2008

EXECUTIVE SUMMARY

Bison Engineering, Inc. (Bison) was retained by Bitter Root RC&D to perform emissions testing for particulate matter less than 2.5 microns (PM_{2.5}), total particulate matter (TPM), nitrogen oxides (NOx) and carbon monoxide (CO) on the Darby School Messersmith Hurst steam-fired hot water boiler located in Darby, Montana. The following table presents the results of the low-fire and high-fire testing.

Table 1: Messersmith Hurst Steam Boiler Stack Emissions

| Messersmith Hurst Steam Hot Water Boiler Darby School, Darby, MT Stack Emissions | | | |
|---|-----------------|----------------------------------|-----------------------------------|
| Emissions | Units | Low-Fire Feb. 13 2008 | High-Fire Feb. 14 2008 |
| PM_{2.5} | Concentration | 0.0503 gr/dscf | 0.0279 gr/dscf |
| | Mass rate | 0.229 lbs/hr | 0.223 lbs/hr |
| | Emission factor | 0.129 lbs/MMBtu | 0.091 lbs/MMBtu |
| TPM | Concentration | 0.082 gr/dscf | 0.053 gr/dscf |
| | Mass rate | 0.373 lbs/hr | 0.425 lbs/hr |
| | Emission factor | 0.212 lbs/MMBtu | 0.172 lbs/MMBtu |
| NOx | Concentration | 51.4 ppmdv | 52.6 ppmdv |
| | Mass rate | 0.20 lbs/hr | 0.34 lbs/hr |
| | Emission factor | 0.113 lbs/MMBtu | 0.139 lbs/MMBtu |
| CO | Concentration | 185 ppmdv | 168 ppmdv |
| | Mass rate | 0.39 lbs/hr | 0.75 lbs/hr |
| | Emission factor | 0.22 lbs/MMBtu | 0.31 lbs/MMBtu |
| Heat Input | | 1.77 MMBtu/hr | 2.46 MMBtu/hr |
| Percent of 3,300,000 Btu/hr | | 53% | 75% |

Table Nomenclature

| | |
|-----------|--|
| gr/dscf | grains per dry standard cubic feet (@ 68°F and 1 atm.) |
| lbs/hr | pounds per hour |
| lbs/MMBtu | pounds per million British thermal units |
| ppmdv | parts per million dry volume |
| MMBtu/hr | million British thermal units per hour |
| % | percent |

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1.0 INTRODUCTION

Bison Engineering, Inc. (Bison) was retained by Bitter Root RC&D to perform air quality emissions testing on the Darby School Messersmith Hurst steam-fired hot water boiler located in Darby, Montana. The testing was performed according to the details listed in this report. The high-fire test was performed on February 13 followed by the low-fire test on February 14, 2008.

This report summarizes the results from the testing project and the operating conditions of the process during the testing. The appendices of this report contain the pretest protocol, spreadsheets, testing field data, production data, nomenclature and formulae, equipment/analyzer calibrations and audits, and Protocol 1 gas certifications.

1.1 Program Organization

Bison is a full service air quality consulting company that provides ambient air and meteorological monitoring, air quality permitting, air quality modeling, regulatory negotiations, process-to-emissions optimization and source testing services. Bison's **Process and Emission Services** team is led by Calvin Loomis, P.E., Project Engineer and Team Leader. Additional team members are Mike Chovanak, E.I.T., Project Engineer; Bill Shaw, P.E., Project Engineer; Dave Blankenship, Senior Environmental Technician; and Jim Wollenberg, Environmental Technician.

Primary: Bitter Root RC&D
Address: 1709 N. First Street
 Hamilton, Montana 59840
Contact: Tom Coston
Phone: 406/363-1444, ext. 5

Facility Info: Darby High School
Contact: Rick Scheele, Maintenance Supervisor
Phone: 406/360-8342 Cell
Email: rscheele@darby.k12.mt.us

Boiler Contact: Messersmith Manufacturing, Inc.
Contact: Gary Messersmith
Phone: 906/466-9010
Email: messersmith@burnchips.com

Consultant: Bison Engineering, Inc.
Address: 1400 11th Avenue
 Helena, MT 59601
Contacts: Jim Wollenberg, ext. 225
 Mike Chovanak, ext. 276
 Cal Loomis, ext. 235
Phone: (406) 442-5768 Fax: (406) 449-6653
Email: bison@bison-eng.com

2.0 EMISSION SOURCE INFORMATION

2.1 Facility Description

Darby School is an educational facility located in Darby, Montana.

2.2 Emission Source Description

The Darby School operates a 3,300,000 Btu/hr Hurst steam-fired hot water boiler manufactured by Messersmith. The boiler has a 50-foot double wall stack with a 20inch inside diameter.



3.0 TEST RESULTS SUMMARY

3.1 Summary of Emissions Determination

The following tables present the results from the February 13-14, 2008, emissions testing on the Messersmith Hurst steam-fired hot water boiler stack. The emission data is presented in grains per dry standard cubic feet (gr/dscf), pounds per hour (lbs/hr), pounds per million British thermal units (lbs/MMBtu) and parts per million dry volume (ppmdv). Additional emission data and nomenclature can be found in the appendices of this report.

Table 2a: Messersmith Hurst Boiler Low-Fire Test Results

| Darby School, Darby, MT Messersmith Hurst Steam-Fired Boiler Low-Fire Emissions, February 13, 2008 | | | | |
|---|-----------|--------------|--------------|-------------|
| | | Run 1 | Run 2 | Avg. |
| Stack Flow | acfm | 1020 | 980 | 1000 |
| | dscfm | 550 | 515 | 533 |
| PM _{2.5} | gr/dscf | 0.0439 | 0.0567 | 0.0503 |
| | lbs/hr | 0.207 | 0.250 | 0.229 |
| | lbs/MMBtu | 0.117 | 0.142 | 0.129 |
| TPM | gr/dscf | 0.0806 | 0.0831 | 0.0819 |
| | lbs/hr | 0.380 | 0.367 | 0.374 |
| | lbs/MMBtu | 0.215 | 0.208 | 0.212 |
| Combustion Gases | | | | |
| NOx | ppmdv | 52.5 | 52.8 | 52.6 |
| | lbs/hr | 0.206 | 0.194 | 0.200 |
| | lbs/MMBtu | 0.117 | 0.110 | 0.113 |
| CO | ppmdv | 160.2 | 176.1 | 168.1 |
| | lbs/hr | 0.384 | 0.396 | 0.390 |
| | lbs/MMBtu | 0.218 | 0.224 | 0.221 |
| Operating Conditions | | | | |
| Oxygen, % dry | | 10.4 | 9.67 | 10 |
| Heat Input, MMBtu/hr | | 1.76 | 1.77 | 1.72 |
| Percent of 3,300,000 But/hr | | 53% | 54% | 53% |

Table 2b: Darby School, Messersmith Hurst Boiler Low-Fire PM Proportions

| Darby School, Darby, MT Messersmith Hurst Steam-Fired Boiler Low-Fire PM Emissions Proportions February 14, 2008 | |
|---|-----|
| PM greater than 2.5 | 39% |

Table 3a: Messersmith Hurst Boiler High-Fire Test Results

| Darby School, Darby, MT Messersmith Hurst Steam-Fired Boiler Low-Fire Emissions, February 14, 2008 | | | | | |
|---|-----------|--------------|--------------|--------------|-------------|
| | | Run 3 | Run 4 | Run 5 | Avg. |
| Stack Flow | acf m | 1972 | 1971 | 1943 | 1962 |
| | dscfm | 996 | 914 | 880 | 930 |
| PM _{2.5} | gr/dscf | 0.0280 | 0.0311 | 0.0246 | 0.0279 |
| | lbs/hr | 0.239 | 0.243 | 0.186 | 0.223 |
| | lbs/MMBtu | 0.086 | 0.095 | 0.091 | 0.0905 |
| TPM | gr/dscf | 0.0566 | 0.0567 | 0.0461 | 0.0531 |
| | lbs/hr | 0.483 | 0.444 | 0.348 | 0.425 |
| | lbs/MMBtu | 0.174 | 0.173 | 0.170 | 0.172 |
| Combustion Gases | | | | | |
| NOx | ppmdv | 54.0 | 54.1 | 46.0 | 51.4 |
| | lbs/hr | 0.384 | 0.352 | 0.289 | 0.342 |
| | lbs/MMBtu | 0.138 | 0.138 | 0.172 | 0.139 |
| CO | ppmdv | 176.7 | 183.6 | 195.5 | 185.3 |
| | lbs/hr | 0.768 | 0.731 | 0.751 | 0.750 |
| | lbs/MMBtu | 0.276 | 0.285 | 0.367 | 0.309 |
| Operating Conditions | | | | | |
| Oxygen, % dry | | 11.7 | 11.7 | 13.3 | 12 |
| Heat Input, MMBtu/hr | | 2.78 | 2.57 | 2.04 | 2.46 |
| Percent of 3,300,000 Btu/hr | | 84% | 78% | 62% | 75% |

Table 3b: Messersmith Hurst Boiler High-Fire PM Proportions

| Darby School, Darby, MT Messersmith Hurst Steam-Fired Boiler High-Fire PM Emissions Proportions February 13, 2008 | |
|--|-----|
| PM greater than 2.5 | 48% |
| Filterable PM _{2.5} | 45% |
| Condensable PM | 8% |

3.2 Production Data

Boiler production data is presented in the test results tables.

3.3 Field Notes

Testing proceeded without interruption. There were no deviations from the methods listed in this report.

4.0 TESTING PROCEDURES

4.1 Sampling Site Locations

Sample site locations were determined by Method 1.

4.2 Test Methods and Procedures

Bison testing personnel performed the following EPA methods as described in Title 40, Code of Federal Regulations (CFR), Part 60, Appendix A:

EPA Reference Method 1, "Sample and Velocity Traverses for Stationary Sources." The objective of Method 1 is to determine a suitable location for testing and to determine the velocity measurement points for the source. The distance upstream to atmosphere from the sampling ports (Distance A) is measured and the distance downstream to the nearest disturbance from the sample points (Distance B) is measured. Distances A and B are applied to Method 1, Figure 1-2 for velocity measurement points. These figures give the minimum number of measurement points according to the dimensions of the source. The number of points and the stack diameter are then applied to Method 1, Table 1-2 to determine equal area measurement points within the source. The results of Method 1 location and velocity point measurement locations are included in the report appendices.

EPA Reference Method 2, "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type-S Pitot Tube)." The objective of Method 2 is to measure stack gas velocity, collect temperature data, and calculate a volumetric flow. Method 2 velocity measurements are performed using a Type S pitot tube. Differential pressures are measured using an inclined manometer, and temperatures are measured using a k-type thermal indicator. Bison has incorporated 0.84 as the Type S pitot tube coefficient (C_p). The average velocity, temperature, static pressure, and source area are used to calculate volumetric flow within the source. This field data is recorded on field data sheets. Copies of the field data, results from the flow calculations, and calibration data can be found in the appendices to this report.

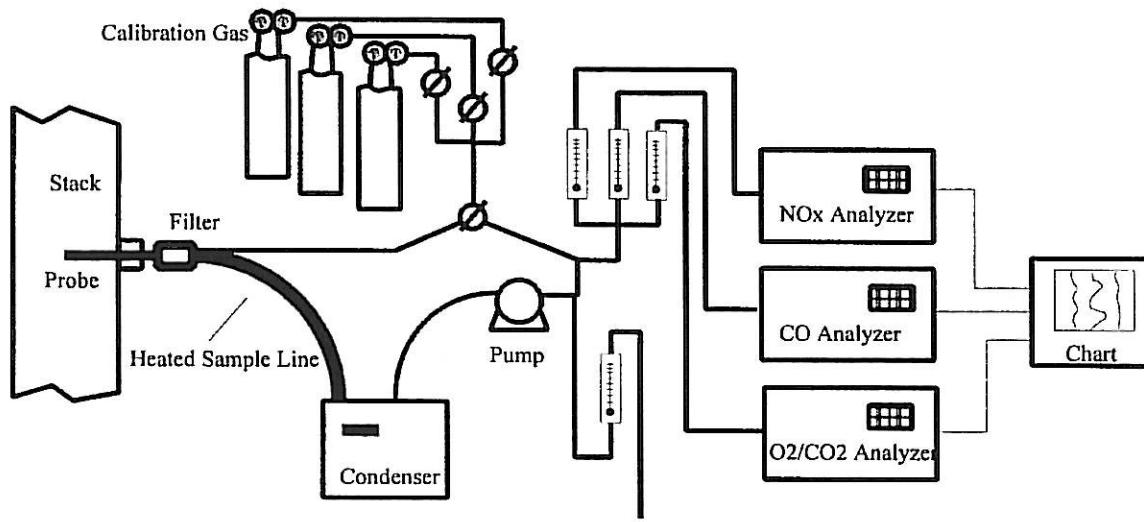
Method 3A, "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)." The objective of Method 3A is to determine the molecular weight of the source stream by determining oxygen (O₂) and carbon dioxide (CO₂) concentrations in the stack gas stream. The principle is to extract a gas sample from a stationary source and route the sample through a conditioning system to a paramagnetic oxygen analyzer and an infrared carbon dioxide analyzer for the measurement of O₂ and CO₂ in percentages (%). The O₂ and CO₂ analyzers calibration adjustments are performed by sending EPA Protocol 1 gas directly to the analyzers. A system calibration is performed by sending calibration gas to the probe and through the system to the analyzers. Bison's CO₂/O₂ analyzer is a Servomex Series 1400 (Serial Numbers 01415/B198 and 014208/901, respectively). The calibration error, system bias and system drift data, and measured concentrations were

recorded on a stripchart or data acquisition system (DAS). A copy of this data is included in a report appendix.

Method 4, "Determination of Moisture Content in the Stack Gases." The objective of Method 4 is to determine the moisture content of a gas stream. The principle of the method is to extract a sample from the source at a constant rate and impinge it through chilled water and silica gel. The moisture is removed from the sample stream and the volume (or mass) of water extracted is determined. The sample volume and water volume (or mass) are used to calculate the moisture content of the stack gas. The results of pre- and post-test dry gas meter (DGM) calibrations can be found in the DGM calibrations table. The DGM calibration data can be found in an appendix of this report. The impinger waters are volumetrically measured on-site and the silica gels are transported to Bison's lab and weighed. The test data is hand-recorded on field data sheets and then entered into spreadsheets for moisture determination calculations. This data and the resulting moisture can be found in the appendices of this report.

EPA Reference Method 7E, "Determination of Nitrogen Oxides Emissions from Stationary Sources." The objective of Method 7E testing is to determine the NOx concentration from the source. Method 7E entails extraction of a gas sample from a stationary source and routing the sample through a conditioning system to an analyzer for the measurement of NOx (NO and NO₂) in ppmvd. The NO₂ analyzer calibration adjustment is performed by sending EPA Protocol 1 gas directly to the analyzer. A system bias check is performed by sending calibration gas to the probe and through the system to the analyzer. Bison uses a Thermo Environmental 42C (NO-NO₂-NO_x) analyzer, Serial Number 42CHL-56022-306. The calibration error, system bias and system drift data, and measured concentrations are recorded on a stripchart or DAS for permanent record.

Typical Layout of a Method 7E and 10 Sampling System



EPA Reference Method 10, "Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)." The objective of Method 10 is to determine the CO concentrations from the source. Method 10 entails extraction of a gas sample from a stationary source and routing the sample through a conditioning system to an analyzer for the measurement of CO in ppmvd. The CO analyzer calibration adjustment is performed by sending EPA Protocol 1 gas directly to the analyzer. A system bias check is performed by sending calibration gas to the probe and through the system to the analyzer. Bison uses a Thermo Environmental Instruments 48C CO Analyzer, Serial Number 48C-55909-305. The calibration error, system bias and system drift data, and measured concentrations are recorded on a stripchart or DAS for permanent record.

EPA Reference Method 19, "Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxides Emissions Rates." Method 19 is employed for the determination of mass rate emissions. Results from Methods 3A, 7E and natural gas dry F factor (F_d) (from Table 19-1) are employed to calculate an NO_x emission rate (E) according to the following steps.

Step 1: Calculate NO_x in pounds per standard cubic feet (lbs/scf). Method 19, Table 19-1, provides factors to convert ppm NO_x to lb/scf.

$$C_d = NO_x \text{ ppm} \times 1.194 \times 10^{-7} \text{ lbs/scf/ppm} = NO_x \text{ lbs/scf}$$

Step 2: Calculate NO_x results in pounds per hour using Table 19-2 "Factors for Various Fuels," using the F_d factors and measured oxygen (O₂).

$$E = F_d^{\text{dscf}/\text{MMBtu}} C_d \frac{20.9}{(20.9 - \% O_2)} = NO_x \text{ lbs/MMBtu}$$

Where: E = pollutant emission rate (lbs/MMBtu)

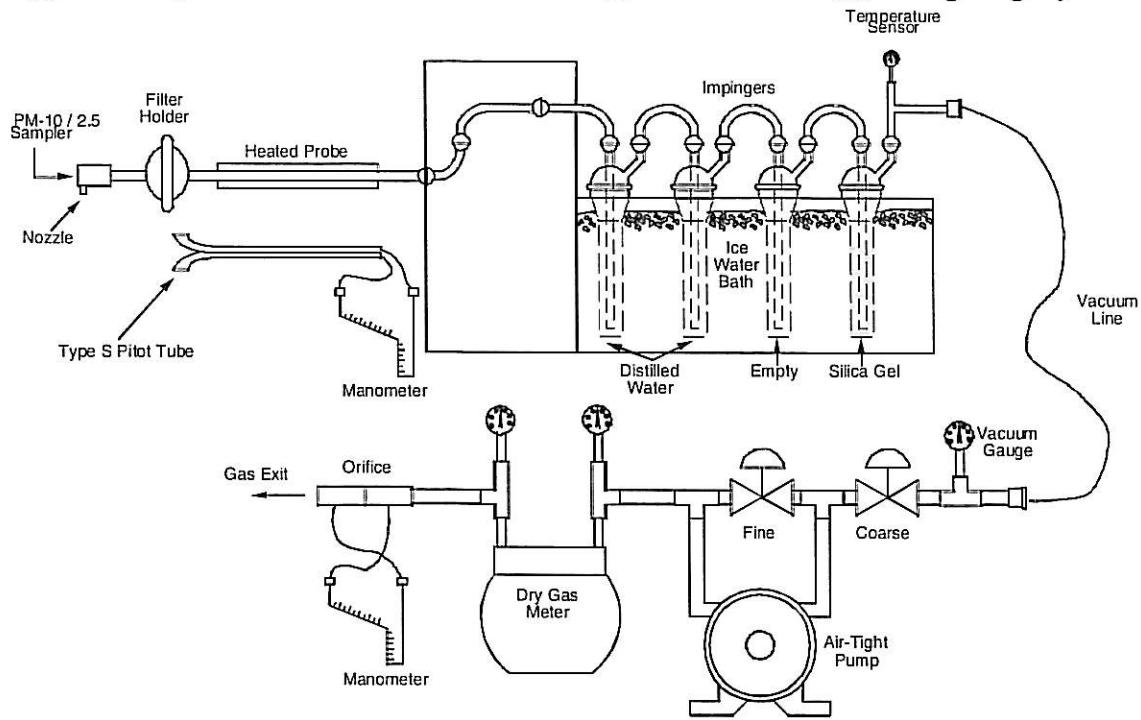
C_d = pollutant concentration dry basis (lbs/scf)

Step 3: Using the fuel usage measured during the test and the heating factor of 969.2 Btu/scf n.g., calculate the NO_x results in pounds per hour as follows.

$$E^{\text{lbs}/\text{MMBtu}} \times 9.692 \times 10^{-4} \text{ MMBtu}/\text{scf n.g.} \times \text{fuel}^{\text{scf n.g.}/\text{hr}} = NO_x \text{ lbs/hr}$$

Conditional Test Method 40, "Determination of PM_{2.5} Emissions (Constant Sampling Rate Procedure)" (Methods 2 & 4 Inclusive). The objective of Method CT40 is to determine the particulate matter (PM) emissions equal to or less than an aerodynamic diameter of 2.5 microns from stationary sources. The principle is to draw the sample stream through an in-stack cyclone which cuts the PM. The matter less than 2.5 microns proceeds to a 0.3 micron filter. Matter less than 0.3 microns is captured in water impingers. CT40 incorporates Method 2 "velocity measurements" and Method 4 "moisture measurements."

Typical Layout of a Method 201A PM₁₀ or CT40 PM_{2.5} Sampling System



4.3 Analytical Methods

Chain of Custody: Bison staff maintained possession of the samples throughout sampling, transport and analysis.

Filter Analysis: Bison weighed filters in an environmentally controlled room. Before field use, the filters were desiccated for a minimum of 24 hours, then weighed and desiccated at 6-hour intervals until a constant pre-test tare was achieved. After the tests, the filters were desiccated for a minimum of 24 hours, then weighed and desiccated at 6-hour intervals until constant post-test weight was achieved. The difference between the average pre-test tare and average post-test weight was the filter mass capture. Sample descriptions are recorded on the field data forms.

Nozzle, Cyclone, Probe and Filter-bell Rinse Analysis: The nozzle, probe and filter-bell were rinsed with acetone. The rinsate was collected in a sample bottle, transferred to a pre-conditioned, tared aluminum sample boat and heated to evaporate the acetone. The boat was again conditioned and weighed to determine "front-half" rinse particulate matter. The rinse mass capture was added to the filter particulate capture to determine "front-half" filterable PM emissions.

Impinger Water: Post-test impinger water description of color and presence of film are recorded on field data sheets. The impinger waters are volumetrically measured after each test run and rinsed with MeCl. The water and rinse is then transferred to uniquely identified sample containers for transport to Bison's lab. At the lab, sample containers are

checked for leakage then the waters are transferred to graduated cylinders where the volumes are checked for leakage.

Impinger Water Organic and Inorganic Matter Analysis: The impinger waters are decanted into a separatory flask and 75 mls of methylene chloride (MeCl) are added and mixed well. The organic fraction is then drained off into a tared beaker and the extraction is performed one more time. The remaining inorganic fraction is drained into a tared beaker. Both beakers are then dried, desiccated and weight gain analysis is performed.

Organic CPM, Methylene Chloride (MeCl) Extractable Matter (MCEM): The impinger waters are transferred to a separatory flask where MeCl is added. The flask is shaken and allowed to settle. The solution separates into two distinct aqueous solutions, and the lower solution is separated off into a tared beaker. This process is repeated. Once the solution has evaporated to less than 50 mls, the solution is transferred to a pre-conditioned, tared boat and allowed to air dry until completely evaporated. After evaporation, the boats are then placed in a desiccator for a minimum of 6 hours after which they are weighed in 6-hour intervals until a constant weight is achieved. This weight gain results in the MCEM.

Inorganic CPM: The remaining water in the flask is drained into another tared beaker and placed on a warming plate to evaporate. Once the water has evaporated to less than 50 mls, the water is transferred to a pre-conditioned, tared boat and allowed to air dry until completely evaporated. After evaporation, the boats are then placed in a desiccator for a minimum of 6 hours after which they are weighed in 6-hour intervals until a constant weight is achieved.

Silica Gel: Bison transports pre-dried silica gel in airtight containers holding approximately 250 grams. Each container is weighed prior to use in a sampling train. After testing, the gel is placed back into the container and reweighed for moisture gain. Pre- and post-test silica gel weights are recorded in the lab, entered into the spreadsheets and may be recorded on field data sheets.

Fuel samples were taken during the testing project and sent to the following lab for ultimate analysis and Btu determination. The lab results are presented in an appendix to this report.

Hazen Research Inc.
4601 Indiana Street
Golden, Colorado 80403
Tel. 303 279-4501
Fax 303 278-1528
Contact: Gerard H. Cunningham, Fuel Laboratory Manager

5.0 QUALITY ASSURANCE AND QUALITY CONTROL

5.1 Documentation and Tracking

Bison uses a project number for document control and tracking for all projects. Each project that Bison works on is assigned a project number. All documentation pertaining to that project is filed in the same place under that project number. This assures all pertinent information can be found easily at a later date.

The tracking number for this project is **BRR208860**.

5.2 Sampling Protocol

Bison's test, laboratory, reporting, and quality assurance procedures conform to the requirements specified in the *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. III, Stationary Source Specific Methods*, published by the U.S. Environmental Protection Agency in August, 1977, as revised and amended (cat. #EPA-600/4-77-027b).

The individual test methods specify handling procedures for physical samples (liquids, traps, etc.). Bison follows the procedures outlined in the appropriate methods as described in EPA 40 CFR Part 60, Appendix A and Appendix B.

5.3 Quality Assurance

Bison's quality assurance program is designed to ensure that all source testing methods are followed and are performed by competent, experienced personnel. Bison's equipment is properly calibrated and maintained in good working order. Procedures for sample collection, recovery, and analysis are performed according to applicable EPA methods. Bison's practices conform to the procedures in the Environmental Protection Agency (EPA) *Quality Assurance Handbook for Air Pollution Measurement Systems*, Volume 3, EPA-600/4-77-0276, 1977, as amended.

Bison personnel calibrate equipment and instruments using standards when applicable or per the procedures of National Institute of Standards and Technology (NIST). Bison's equipment is manufactured to meet all applicable EPA criteria and parameters. Bison defines a calibration as the procedure of changing a measurement system or device to match a constant or standard measurement system or device; an "audit" checks the variance between the value and a standard or a precalibration.

Emission testing quality assurance checks and quality controls (QA/QC) require three steps: before, during, and after field testing. "Before" QA/QC procedures are performed in Bison's lab, "during" QA/QC checks are recorded on the field data sheets, and "after" QA/QC procedures are performed at Bison's lab. These data can be found in the appendices. The following table describes Bison's QA/QC, calibration and audit procedures and schedule.

Table 4: Equipment Calibration and Audit Procedures

| Parameter or Unit | Schedule and Requirement | Method Reference |
|-----------------------------|---|----------------------|
| Acetone / DI water | Blank analysis on the rinse solution. | Method 5, 3.2 |
| Probe nozzle | Calibration according to reference. | Method 5, 5.1 |
| Isolated Type S pitot tubes | Calibration prior to initial field use. | Method 2, 10.1 |
| | Re-examined after each field use. | Method 2, 10.1.5.2.1 |
| Temperature gauges | Audited on-site and/or after each field use. | Method 2, 10.3.1 |
| Probe heater | Calibration prior to initial field use. | Method 5, 5.4 |
| Barometer | Calibrated against Hg barometer. | Method 2, 10.4 |
| Metering system | Calibration prior to use. | Method 5, 10.3.1 |
| | Calibration after use. | Method 5, 10.3.2 |
| Analytical balance | Calibrated and/or audited each year by independent auditor. | N/A |
| | Audited during sample weighing. | N/A |
| Analyzers | Analyzer calibration error, ACE. | Method 7E, 8.5 |
| | NO ₂ to NO conversion test. | Method 7E, 8.2.4 |
| Sample system | Sample system bias check, SB. | Method 7E, 8.5 |
| | Zero and calibration drift tests. | Method , 7E.8.5 |

5.4 Volumetric Sampling Equipment Calibrations

Volumetric Sampling by Dry Gas Meter (DGM)

Volumetric sampling by DGM must be initially calibrated across its full operating range then audited after each testing project. The post-test audit must be within 5% of its initial calibration. Should the DGM not be within the 5% criteria, the DGM factors must be used that will give the lowest sample volume. Calibration data can be found in an appendix to this report. The following table presents the results of the pre- and post-test DGM calibrations and audits.

Table 5: Meter Box Calibration Results

| Bison Engineering Equipment Calibration Record | | | | |
|--|-----------------|------------------|---------|--------------------------|
| Unit | Pre-Calibration | Post-Calibration | Results | Required |
| Meter Box 4, "Y" | 1.049 | 1.041 | 0.01% | ±5% from pre-calibration |

Method 5, Section 5.3.3, states that, should the pre- and post-"Y" factor calibrations differ more than 5%, the lesser "Y" value shall be used in the calculations.

5.5 Instrument Calibration, Maintenance and Standards

Bison uses a field barometric pressure gauge that is calibrated prior to each field deployment against a mercury-in-glass standard barometer. Temperature calibrations are performed using a mercury-in-glass NIST-traceable thermometers.

Bison uses RATA-class calibration gases for all emission testing projects which are certified as EPA Protocol 1 gases and are purchased from Scott Specialty Gases. The calibration gas certifications are included in the appendix of this report.

Calibration adjustments of the analyzers are performed by sending the Protocol 1 gas directly to the analyzers. A system audit is performed before and after each test run by sending calibration gas to the probe and through the system to the analyzers. The results of these calibrations and audits can be found in the spreadsheets located in the appendices.

5.6 Data Acquisition, Reduction and Validation

Test data such as velocities, temperatures and isokinetic sampling are hand-recorded on field data sheets. The data is then entered into computer spreadsheets where QC/QA and emission calculations are performed according to the methods. An appendix of this report contains nomenclature and formulae for reference. All raw field data is supplied in an appendix to this report. The appendix contains some example calculations; additional examples will be supplied upon request.

Rounding of Significant Figures

If the first digit to be discarded is less than five, the last digit retained should not be changed. When the first digit discarded is greater than five, or if it is a five followed by at least one digit other than 0, the last figure retained should be increased by one unit. When the first digit discarded is exactly five, followed only by zeros, the last digit retained should be rounded upward if it is an odd number, but no adjustment made if it is an even number.

For example, if the emission standard is 90, than 90.357 would be rounded to 90, 90.639 would be rounded to 91, 90.500 would be rounded to 90, and 91.500 would be rounded to 92.

| Standard | Number | Rounded To |
|-----------------|---------------|-------------------|
| 90 | 90.357 | 90 |
| 90 | 90.639 | 91 |
| 90 | 91.500 | 92 |

APPENDIX A:
LOW-FIRE PM TEST DATA

Bison Engineering
Method 201A Spreadsheet
Method 201A PM₁₀ & CT40 PM_{2.5} Test

| | |
|----------|------------------|
| COMPANY | Bitter Root |
| FACILITY | Darby School |
| LOCATION | Darby, MT |
| SOURCE | Boiler, Low Fire |
| DATE | Feb 13, 08 |

Method 201A PM10 & CT Method 40 PM2.5

| | | |
|-----------------|--------------|----------------|
| Client Facility | Bitter Root | Number of Runs |
| Location | Darby School | |
| Source | Darby, MT | 2 |

| | | |
|------------|------------|------------|
| Test date | Feb 13, 08 | Feb 13, 08 |
| Start time | 4:30 | 5:32 |
| Test run | One | Two |

Preliminary info

| | | | |
|---------------------------|------|-------|-------|
| Barometric pressure [Bp] | "Hg | 26.67 | 26.67 |
| Stack Diameter | inch | 20 | 20 |
| stack exit area | sqft | 2.18 | 2.18 |
| Meter box ID | | 2 | 2 |
| meter box Yi | | 1.003 | 1.003 |
| meter box delta H@ | | 1.76 | 1.76 |
| Pitot tube coefficient Cp | | 0.84 | 0.84 |

Test Information

| | | | |
|-----------------------------------|-------|-------|-------|
| nozzle size [nz] | inch | 0.35 | 0.35 |
| filter number | | 2953 | 2954 |
| Sample points | | 12 | 12 |
| Test duration | min | 48 | 48 |
| Isokinetics [i] | % | 190 | 213 |
| D50 cut rate | | 10.17 | 10.15 |
| Sample volume, eq 4.3 | dscf | 15.28 | 15.22 |
| avg delta P | "H2O | 0.012 | 0.010 |
| avg sqrt delta P | "H2O | 0.108 | 0.102 |
| 201A Constant sample rate delta H | "H2O | 0.45 | 0.60 |
| CT40 Constant sample rate delta H | "H2O | 0.41 | 0.54 |
| avg meter temp [Tm] | deg F | 66.8 | 72.9 |

Stack Information

| | | | | AVERAGES |
|-----------------------------------|------------|-------|-------|----------|
| avg stack temp [Ts] | deg F | 321 | 340 | 331 |
| avg ABS stack temp [Ts] | deg R | 781 | 800 | 791 |
| actual stack flow | acf m | 1020 | 980 | 1000 |
| actual stack velocity [Vs] | ft/sec | 7.8 | 7.5 | 8 |
| Standard stack flow | dscfm | 550 | 515 | 533 |
| Standard stack flow | dscf/hr | 33003 | 30919 | 31961 |
| stack moisture [bws], eq 4.4 | % v/v | 10.53 | 10.58 | 11 |
| measured static pressure | "H2O | 0 | 0 | 0 |
| stack static pressure [ps] | "Hg | 26.67 | 26.67 | 26.67 |
| Oxygen content | % O2 | 10.4 | 9.67 | 10 |
| Carbon dioxide content | % CO2 | 10.6 | 11.33 | 11 |
| Wet (Actual) Molecular Weight, Ms | lb/lb.mole | 28.8 | 28.9 | 28.9 |
| Dry Molecular Weight, Md | lb/lb.mole | 30.1 | 30.2 | 30.2 |

Lab Information

| | | | | |
|---|-------------|--------|--------|--|
| Impinger H2O Gain | mls | 35 | 35 | |
| Impinger H2O volume [Vwc(STD)], eq 4.1 | scf | 1.65 | 1.65 | |
| Silica Gel H2O Gain | grams (g) | 3.22 | 3.28 | |
| Silica Gel volume [Vsg(STD)], eq 4.2 | scf | 0.15 | 0.15 | |
| Lab Data, cyclone > than PM10 weight gain | grams (g) | NA | NA | |
| Lab Data, cyclone > PM2.5 weight gain | g | 0.0363 | 0.0261 | |
| Lab Data, cyclone PM2.5 weight gain | g | 0.0021 | 0.0043 | |
| Lab Data, Filter PM2.5 weight gain | g | 0.0364 | 0.0450 | |
| Lab data condensable PM (CPM) | g | 0.0026 | 0.0036 | |
| Lab data MeCl Matter (MCEM) | g | 0.0024 | 0.0030 | |
| cyclone > PM2.5 weight gain | grains (gr) | 0.5602 | 0.4028 | |
| cyclone PM2.5 weight gain | gr | 0.0324 | 0.0664 | |
| Filter PM2.5 weight gain | gr | 0.5617 | 0.6945 | |
| condensable PM (CPM) | gr | 0.0401 | 0.0556 | |
| MeCl Matter (MCEM) | gr | 0.0370 | 0.0463 | |

Grain loading Emissions

| | | | | AVERAGES |
|-------------------------|---------|--------|--------|----------|
| > PM2.5 cut | gr/dscf | 0.0367 | 0.0265 | 0.0316 |
| PM 2.5 cyclone & filter | gr/dscf | 0.0389 | 0.0500 | 0.0444 |
| condensable PM (CPM) | gr/dscf | 0.0026 | 0.0036 | 0.0031 |
| MeCl Matter (MCEM-CPM)) | gr/dscf | 0.0024 | 0.0030 | 0.0027 |
| EPA PM2.5 + CPM | gr/dscf | 0.0439 | 0.0567 | 0.0503 |
| Total PM | gr/dscf | 0.0806 | 0.0831 | 0.0819 |

Mass Rate Emissions

| | | | | AVERAGES |
|-------------------------|--------|-------|-------|----------|
| > PM2.5 cut | lbs/hr | 0.173 | 0.117 | 0.1448 |
| PM 2.5 cyclone & filter | lbs/hr | 0.183 | 0.221 | 0.2020 |
| condensable PM (CPM) | lbs/hr | 0.012 | 0.016 | 0.0142 |
| MeCl Matter (MCEM-CPM)) | lbs/hr | 0.011 | 0.013 | 0.0124 |
| EPA PM2.5 + CPM | lbs/hr | 0.207 | 0.250 | 0.2287 |
| Total PM | lbs/hr | 0.380 | 0.367 | 0.3736 |

Emission Factor

| | | | | |
|------------------------------------|-----------------|-------|-------|--------|
| lab analysis Fd @ 0% oxygen | dscf/MMBtu @ 0% | 9399 | 9399 | 9399 |
| lab analysis Fd @ stack conditions | dscf/MMBtu @ SK | 18708 | 17492 | 18100 |
| EPA PM2.5 + CPM | lbs/MMBtu | 0.117 | 0.142 | 0.1295 |
| TPM | lbs/MMBtu | 0.215 | 0.208 | 0.2116 |

Boiler operating rate MMBtu/hr 1.76 1.77 |

Bison Engineering, Method 201A PM10 & CT40 PM_{2.5} Spreadsheets

Data by jw Checked by cwl

| | | | |
|------------|-------------|-----------|------------------|
| Facility: | Bitter Root | Location: | Darby, MT |
| Operators: | iw, mtc | Filter #: | 2953 |
| | | Source: | Boiler, Low Fire |

| PRELIMINARY INFO. | | | |
|-------------------|------|--------------------|----------------------|
| Pm | Bp | Length | Width |
| Diam | 20 | | |
| Stack AREA | | | |
| Meter Box | | Y_1 | $\Delta H @$ |
| | 2 | | 1.76 |
| PRE TEST INFO | | 26.67 (m^3) | Rect. sqft (sqft) |
| Rnd soft | 2.18 | 0 | |
| | 2.18 | 1.003 | |

| TRAVERSE INFO | | | |
|------------------------|----------|----------------------------|--|
| Assumed Meter Temp | 60.0 | (deg F) | |
| Target Run Time | 48.0 | (min) | |
| Total Number of Points | 12 | | |
| Static, gage pressure | 0.00 | (cmH_2O) | |
| Slack Temp, T_s | 320.0 | (deg F) | |
| Abs stack Temp, T_s | 780 | (deg R) | |
| Oxygen, dry | 10.4 | (% v/v d) | |
| Oxygen, wet | 9.152 | (% v/v w) | |
| Carbon Dioxide, dry | 10.6 | (% v/v d) | |
| Molecular weight, dry | 30.112 | (lb/lb-mole) | |
| Molecular weight, wet | 28.65856 | (lb/lb-mole) | |

Revised Sept 08/01 by CWL

| S | I | A | C | K | Flow |
|----------|----------|---------|------------|---------|---------|
| | | | | | dscfm |
| Vel head | 200ACT40 | Stack | Meter Temp | Assumed | Rolling |
| delta P | sqr t dP | delta H | In | % l | % l |
| 0.009 | 0.09 | 0.45 | 315 | 57.5 | 197.85 |
| 0.011 | 0.10 | 0.45 | 320 | 58 | 195 |
| 0.013 | 0.11 | 0.45 | 325 | 58 | 215.86 |
| 0.015 | 0.12 | 0.45 | 325 | 59 | 212 |
| 0.014 | 0.12 | 0.45 | 323 | 66 | 191.00 |
| 0.012 | 0.11 | 0.45 | 319 | 71 | 178.76 |
| 0.010 | 0.10 | 0.45 | 318 | 71 | 172.93 |
| 0.011 | 0.10 | 0.45 | 321 | 70 | 170 |
| 0.010 | 0.10 | 0.45 | 321 | 70 | 188 |
| 0.011 | 0.10 | 0.45 | 323 | 72 | 188 |
| 0.013 | 0.11 | 0.45 | 326 | 72 | 179 |
| 0.012 | 0.11 | 0.45 | 320 | 72 | 187 |
| 0.010 | 0.10 | 0.45 | 318 | 71 | 187 |
| 0.011 | 0.10 | 0.45 | 321 | 71 | 189 |
| 0.013 | 0.11 | 0.45 | 326 | 72 | 190 |
| 0.012 | 0.11 | 0.45 | 320 | 72 | 192.80 |
| 0.010 | 0.10 | 0.45 | 319 | 71 | 190.85 |
| avg. dP | avg. [dP | dH | Ts | Tm | Tm °F |
| 0.012 | 0.108 | 0.45 | 321.17 | 66.79 | Ts °R |
| | | | | 526.79 | Tm °R |
| | | | | 781.17 | |
| | | | | | 1021 |
| | | | | 7.80 | |
| | | | | | 550 |

| S I A C | | | | | | | | | | | | | | | | |
|---------|--------------|--------|---------------|--------|----------|----------|--------|---------|--------|------------|---------|--------|---------|--------|--------|-----|
| Test | Pre traverse | | Point | Run | Metr/Vol | Vel head | 201A | CT40 | Stack | Meter Temp | Assumed | Actual | Rolling | Vel. | Flow | |
| No | dP | sqr dP | Time | Time | 807.00 | delta P | sqr dP | delta H | Temp | In | Out | Avg | % l | %l | dscfm | |
| 1 | 0.009 | 0.10 | 3.5 | 3.5 | 808.110 | 0.009 | 0.09 | 0.45 | 315 | 58 | 57 | 57.5 | 197.85 | 195 | 6.84 | |
| 2 | 0.012 | 0.11 | 3.9 | 7.4 | 809.600 | 0.011 | 0.10 | 0.45 | 320 | 60 | 57 | 58.5 | 215.86 | 212 | 7.59 | |
| 3 | 0.013 | 0.11 | 4.2 | 11.6 | 811.140 | 0.013 | 0.11 | 0.45 | 325 | 60 | 58 | 59 | 191.00 | 188 | 8.27 | |
| 4 | 0.017 | 0.13 | 4.5 | 16.1 | 812.810 | 0.015 | 0.12 | 0.45 | 325 | 66 | 59 | 62.5 | 178.76 | 176 | 8.89 | |
| 5 | 0.016 | 0.12 | 4.4 | 20.5 | 814.360 | 0.014 | 0.12 | 0.45 | 323 | 71 | 69 | 70 | 172.93 | 170 | 8.57 | |
| 6 | 0.013 | 0.12 | 4.0 | 24.5 | 815.740 | 0.012 | 0.11 | 0.45 | 319 | 71 | 69 | 70 | 182.46 | 179 | 187 | |
| 7 | 0.011 | 0.10 | 3.7 | 28.2 | 817.080 | 0.010 | 0.10 | 0.45 | 318 | 71 | 69 | 70 | 209.69 | 206 | 189 | |
| 8 | 0.011 | 0.11 | 3.7 | 31.9 | 818.360 | 0.010 | 0.10 | 0.45 | 321 | 71 | 70 | 70.5 | 200.50 | 197 | 7.24 | |
| 9 | 0.013 | 0.11 | 3.9 | 35.8 | 819.730 | 0.011 | 0.10 | 0.45 | 323 | 72 | 70 | 71 | 194.18 | 191 | 7.60 | |
| 10 | 0.013 | 0.11 | 4.2 | 40.0 | 821.350 | 0.013 | 0.11 | 0.45 | 326 | 72 | 70 | 71 | 196.50 | 193 | 191 | |
| 11 | 0.013 | 0.11 | 4.0 | 44.0 | 822.810 | 0.012 | 0.11 | 0.45 | 320 | 72 | 70 | 71 | 192.80 | 190 | 191 | |
| 12 | 0.011 | 0.11 | 3.7 | 47.7 | 824.030 | 0.010 | 0.10 | 0.45 | 319 | 71 | 70 | 70.5 | 190.85 | 188 | 190 | |
| | avg dP | avg dP | sample volume | 17.030 | avg dP | avg dP | avg dP | avg dP | avg dP | avg dP | avg dP | avg dP | avg dP | avg dP | avg dP | |
| | 0.013 | 0.112 | | | 0.012 | 0.108 | 0.45 | 0.45 | 321.17 | Tm | Tm | Tm | 66.79 | Tm °F | 601.13 | |
| | | | | | | | | | | 781.17 | Ts | 781.17 | Ts | 526.79 | Tm °R | 550 |

Test Run 2 Bison Engineering, Method 201A PM₁₀ & CT40 PM_{2.5} Spreadsheet

Data by _____ Checked by cwl

| | | | | | |
|--|-------------|------------------------|------------------|------------------------|------------------------|
| Facility: | Bitter Root | Location: | Darby, MT | Date: | Feb 13, 08 |
| Operators: | | Source: | Boiler, Low Fire | Start time: | 5:32 End time: 6:18 |
| PRELIMINARY INFO. | | | | | |
| Pm Bp | | | | | |
| (inches) | Diam 20 | Length 0 | Width 0 | Rnd sqft 0 | Rect. sqft 0 |
| Stack AREA | Meter Box | Yi | Delta H @ 2 | 1.003 | 1.76 (sqft) |
| PRE TEST INFO | | | | | |
| Assumed moisture | 3.0 | (%) | 3.0 | (%) | (deg F) |
| Assumed Meter Temp | 75.0 | (deg F) | 75.0 | (deg F) | (min) |
| Target Run Time | 48.0 | (min) | 48.0 | (min) | |
| Total Number of Points | 12 | | | | |
| TRAVERSE INFO | | | | | |
| Pg Static, gage pressure | 0.00 | ("H2O) | 0.00 | ("H2O) | (deg F) |
| Stack Temp, ts | 380.0 | (deg F) | 380.0 | (deg F) | (deg R) |
| O ₂ Abs stack Temp, Ts | 840 | (deg R) | 9.7 | (% v/v d) | |
| CO ₂ Oxygen, dry | 9.7 | (% v/v d) | 9.3799 | (% v/v w) | |
| Oxygen, wet | 11.3 | (% v/v d) | 11.3 | (% v/v w) | |
| Carbon Dioxide, dry | 30.1996 | (lb/lb.mole) | 30.1996 | (lb/lb.mole) | |
| Molecular weight, dry | 29.835612 | (lb/lb.mole) | 29.835612 | (lb/lb.mole) | |
| Molecular weight, wet | | | | | |
| NOZZLE SELECTION | | | | | |
| CT40 N@125 N2@138 N3@156 N4@172 N5@188 N6@20 N7@22 N8@25 | | | | | |
| H ₂ O Nozzle Diameter estimate | 0.520 | | 0.520 | Selected > | 0.35 |
| H ₂ O delta P (min) | ERR | Avg | ERR | Avg | ERR |
| H ₂ O delta P (max) | NA | NA | NA | NA | NA |
| H ₂ O Alt - delta P (min) | ERR | ERR | ERR | ERR | ERR |
| H ₂ O Alt - delta P (max) | 0.141 | ERR | 0.127 | ERR | ERR |
| POST TEST INFO | | | | | |
| Impinger water | 35 | Silica gel | 35 | Silica gel | 3.28 (g) |
| CALCULATED RESULTS | | | | | |
| P _s Stack pressure, Ps | 256.98 | (micropoise) | 26.67 | ("Hg) | |
| Bws % H ₂ O in Stack | 0.741 | (ft ³ /min) | 10.58 | (lb/lb.mole) | |
| ΔH 201A Delta H ==> | 0.60 | ("H2O) | 28.91 | (dsfc) | |
| RANGE [] 0.54 - 50 °F | 0.68 | + 50 °F | 15.22 | (min) | |
| us CT40 stack viscosity | 248.44 | (micropoise) | 45.3 | (micropoise) | |
| C Cunningham Corr. Factor | 1.13 | | 240.29 | (micropoise) | |
| D _{50L} Lower limit cut diameter | 9.28 | (micrometers) | 1.12 | (micrometers) | |
| D _{50U} Cut diam for cyclone | 10.14 | (micrometers) | 9.30 | (micrometers) | |
| Qs CT40 Cyclone flow rate | 0.702 | (ft ³ /min) | 10.15 | (micrometers) | |
| Nre Reynolds number | 2313 | Nre < 3162 * | 0.67 | (ft ³ /min) | |
| ΔH CT40 Delta H ==> | 0.54 | ("H2O) | 213 | (%) | |
| RANGE [] 0.48 - 50 °F | 0.61 | + 50 °F | 10.2 | (μm) | |
| 1 Isokinetic Avg, { 80 < i < 120 } | | | | | |
| D50 D50 Cut Rate, { 9 < d50 < 11 } | | | | | |
| S T A C K | | | | | |
| Assumed | Actual | Rolling | Vel. | Flow | Flow |
| % I | % I | % I | ft/sec | acfm | dsfcfm |
| 199.03 | 216 | 216 | 6.90 | 903 | 481 |
| 203.35 | 221 | 218 | 7.29 | 955 | 505 |
| 185.42 | 201 | 213 | 8.01 | 1049 | 552 |
| 161.03 | 175 | 203 | 7.68 | 1006 | 528 |
| 260.88 | 283 | 219 | 8.04 | 1052 | 550 |
| 185.53 | 201 | 216 | 7.68 | 1006 | 528 |
| 189.21 | 205 | 215 | 7.32 | 958 | 503 |
| 192.21 | 209 | 214 | 6.96 | 911 | 477 |
| 195.73 | 212 | 214 | 7.34 | 961 | 502 |
| 187.67 | 204 | 213 | 8.01 | 1049 | 552 |
| 180.29 | 196 | 211 | 7.67 | 1004 | 528 |
| 180.29 | 229 | 213 | 6.93 | 907 | 478 |
| T _m °F | 72.88 | T _m °F | | | |
| T _m °R | 532.88 | T _m °R | | | |
| avg dP | 0.45 | 340.25 | T _m | | |
| avg sqrt dP squared | 0.102 | 800.25 | T _m | | |
| avg sqrt dP squared | 0.012 | 7.49 | 980 | 515 | |

Revised Sept.08/01 by Cwl

| Sample Identification | Filter # | Date | Tare 1 (g) | Date | Tare 2 (g) | Date | Average | Filter # | Date | Final 1 (g) | Date | Final 2 (g) | Date | Average | Gain | |
|---------------------------------|----------------------------------|-------|------------|------------|------------|------------|---------|----------|-------|-------------|-------------|-------------|-------------|---------|---------|----------|
| Vol (ml) | Sample Identification | Pan # | Date | Tare 1 (g) | Date | Tare 2 (g) | Date | Average | Pan # | Date | Final 1 (g) | Date | Final 2 (g) | Date | Average | Gain |
| 19.7 | Darby School + 2.5 Micron Run 1 | 1382 | 1/29/2008 | 2.5202 | 2/8/2008 | 2.5205 | 0.0003 | 2.5204 | 1382 | 2/15/2008 | 2.5566 | 2/20/2008 | 2.5568 | 0.0002 | 2.5567 | 0.03635 |
| 10.3 | Darby School + 2.5 Micron Run 2 | 1383 | 1/29/2008 | 2.5417 | 2/8/2008 | 2.5416 | -0.0001 | 2.5417 | 1383 | 2/15/2008 | 2.5678 | 2/20/2008 | 2.5679 | 0.0001 | 2.5679 | 0.02620 |
| 24.6 | Darby School + 2.5 Micron Run 4 | 1384 | 1/29/2008 | 2.5412 | 2/8/2008 | 2.5410 | -0.0002 | 2.5411 | 1384 | 2/15/2008 | 2.5652 | 2/20/2008 | 2.5653 | 0.0002 | 2.5653 | 0.02420 |
| 20.6 | Darby School + 2.5 Micron Run 4A | 1385 | 1/29/2008 | 2.5241 | 2/8/2008 | 2.5241 | 0.0000 | 2.5241 | 1385 | 2/15/2008 | 2.5506 | 2/20/2008 | 2.5505 | -0.0002 | 2.5505 | 0.02640 |
| 21.8 | Darby School + 2.5 Micron Run 5 | 1386 | 1/29/2008 | 2.5298 | 2/8/2008 | 2.5298 | 0.0000 | 2.5298 | 1386 | 2/15/2008 | 2.5546 | 2/20/2008 | 2.5546 | 0.0000 | 2.5546 | 0.02480 |
| 100 | H2O Blank from Box | 1391 | 1/29/2008 | 2.5289 | 2/8/2008 | 2.5290 | 0.0001 | 2.5290 | 1391 | 2/8/2008 | 2.5326 | 2/22/2008 | 2.5328 | 0.0002 | 2.5327 | 0.00375 |
| 100 | H2O Blank from bottle | 1392 | 1/29/2008 | 2.5220 | 2/8/2008 | 2.5220 | 0.0000 | 2.5220 | 1392 | 2/8/2008 | 2.5270 | 2/22/2008 | 2.5272 | 0.0002 | 2.5271 | 0.00510 |
| 100 | Acetone Blank | 1393 | 1/29/2008 | 2.5287 | 2/8/2008 | 2.5287 | 0.0000 | 2.5287 | 1393 | 2/7/2008 | 2.5277 | 2/20/2008 | 2.5277 | 0.0000 | 2.5277 | -0.0100 |
| 100 | H2O Blank | 1394 | 1/29/2008 | 2.5192 | 2/7/2008 | 2.5193 | 0.0001 | 2.5193 | 1394 | 2/7/2008 | 2.5211 | 2/18/2008 | 2.5210 | -0.0001 | 2.5211 | 0.01180 |
| 79.4 | Darby School -2.5 micron Run 1 | 1401 | 2/7/2008 | 2.5154 | 2/11/2008 | 2.5157 | 0.0003 | 2.5156 | 1401 | 12/15/2008 | 2.5179 | 2/17/2008 | 2.5178 | 0.0003 | 2.5178 | 0.00220 |
| 49 | Darby School -2.5 micron Run 2 | 1402 | 2/7/2008 | 2.5716 | 2/11/2008 | 2.5717 | 0.0001 | 2.5717 | 1402 | 12/15/2008 | 2.5759 | 2/22/2008 | 2.5760 | 0.0001 | 2.5760 | 0.00430 |
| 58.3 | Darby School -2.5 micron Run 4 | 1403 | 2/7/2008 | 2.5336 | 2/11/2008 | 2.5338 | 0.0002 | 2.5337 | 1403 | 12/15/2008 | 2.5352 | 2/22/2008 | 2.5353 | 0.0001 | 2.5353 | 0.00155 |
| 55.1 | Darby School -2.5 micron Run 4A | 1404 | 2/7/2008 | 2.5533 | 2/11/2008 | 2.5535 | 0.0002 | 2.5534 | 1404 | 12/15/2008 | 2.5573 | 2/22/2008 | 2.5574 | 0.0001 | 2.5574 | 0.00395 |
| 45.9 | Darby School -2.5 micron Run 5 | 1405 | 2/7/2008 | 2.5380 | 2/11/2008 | 2.5381 | 0.0001 | 2.5381 | 1405 | 12/15/2008 | 2.5392 | 2/22/2008 | 2.5393 | 0.0001 | 2.5393 | 0.01120 |
| Darby Impingers Run 1 | | 1406 | 2/7/2008 | 2.5827 | 2/11/2008 | 2.5827 | 0.0000 | 2.5827 | 1406 | 2/20/2008 | 2.5853 | 2/21/2008 | 2.5854 | 0.0001 | 2.5854 | 0.02665 |
| Darby Impingers Run 2 | | 1407 | 2/7/2008 | 2.5623 | 2/11/2008 | 2.5622 | -0.0001 | 2.5623 | 1407 | 2/20/2008 | 2.5659 | 2/21/2008 | 2.5660 | 0.0001 | 2.5660 | 0.00370 |
| Darby Impingers Run 4 | | 1408 | 2/7/2008 | 2.5439 | 2/11/2008 | 2.5439 | 0.0000 | 2.5439 | 1408 | 2/20/2008 | 2.5444 | 2/21/2008 | 2.5444 | 0.0000 | 2.5444 | 0.00050 |
| Darby Impingers Run 4A | | 1409 | 2/7/2008 | 2.5699 | 2/11/2008 | 2.5699 | 0.0000 | 2.5699 | 1409 | 2/20/2008 | 2.5734 | 2/21/2008 | 2.5734 | 0.0000 | 2.5734 | 0.00350 |
| Darby Impingers Run 5 | | 1410 | 2/7/2008 | 2.5852 | 2/11/2008 | 2.5852 | 0.0000 | 2.5852 | 1410 | 2/20/2008 | 2.5887 | 2/21/2008 | 2.5887 | 0.0001 | 2.5887 | 0.00345 |
| Darby Methylen Chloride Run 1 | | 1415 | 2/7/2008 | 2.5530 | 2/11/2008 | 2.5531 | 0.0001 | 2.5531 | 1415 | 2/20/2008 | 2.5554 | 2/21/2008 | 2.5557 | 0.0003 | 2.5556 | 0.00250 |
| Darby Methylen Chloride Run 2 | | 1416 | 2/7/2008 | 2.5047 | 2/11/2008 | 2.5046 | -0.0001 | 2.5047 | 1416 | 2/20/2008 | 2.5076 | 2/21/2008 | 2.5078 | 0.0004 | 2.5078 | 0.00315 |
| Darby Methylen Chloride Run 4 | | 1417 | 2/7/2008 | 2.5691 | 2/11/2008 | 2.5693 | 0.0002 | 2.5692 | 1417 | 2/20/2008 | 2.5710 | 2/21/2008 | 2.5714 | 0.0004 | 2.5712 | 0.00200 |
| Darby Methylen Chloride Run 4A | | 1418 | 2/7/2008 | 2.5037 | 2/11/2008 | 2.5037 | 0.0000 | 2.5037 | 1418 | 2/20/2008 | 2.5058 | 2/21/2008 | 2.5058 | 0.0000 | 2.5058 | 0.00210 |
| Darby Methylen Chloride Run 5 | | 1419 | 2/7/2008 | 2.5810 | 2/11/2008 | 2.5810 | 0.0000 | 2.5810 | 1419 | 2/20/2008 | 2.5828 | 2/21/2008 | 2.5828 | 0.0000 | 2.5828 | 0.01180 |
| Water Blank | | 1424 | 2/7/2008 | 2.5301 | 2/11/2008 | 2.5301 | 0.0000 | 2.5301 | 1424 | 2/20/2008 | 2.5364 | 2/21/2008 | 2.5366 | 0.0002 | 2.5365 | 0.00640 |
| Acetone Blank | | 1425 | 2/7/2008 | 2.5414 | 2/11/2008 | 2.5413 | -0.0001 | 2.5414 | 1425 | 2/20/2008 | 2.5424 | 2/21/2008 | 2.5424 | 0.0000 | 2.5424 | 0.0105 |
| Methylen Chloride Blank | | 1426 | 2/7/2008 | 2.5346 | 2/11/2008 | 2.5349 | 0.0003 | 2.5348 | 1426 | 2/20/2008 | 2.5348 | 2/21/2008 | 2.5346 | -0.0002 | 2.5347 | -0.00005 |
| 71.9 Townsend Probe Rinse Run 1 | | 1427 | 2/11/2008 | 2.5572 | 2/22/2008 | 2.5573 | 0.0001 | 2.5573 | 1427 | 2/22/2008 | 2.5603 | 2/25/2008 | 2.5602 | -0.0003 | 2.5602 | 0.00290 |

APPENDIX B:
LOW-FIRE NO_x AND CO TEST DATA

Darby Low Fire NOx CO test data

| | | Run 1 | Run 2 | Avg. |
|-----------------------------------|-----------|-----------|-----------|-----------|
| Stack Flow | dscfh | 33003 | 30919 | 31961 |
| Heat input | MMBtu/hr | 1.76 | 1.77 | 1.8 |
| NOx source concentration | ppmvd | 52.5 | 52.8 | 52.6 |
| NOx concentration, M19 conversion | lbs/dscf | 6.242E-06 | 6.287E-06 | 6.264E-06 |
| NOx mass rate | lbs/hr | 0.206 | 0.194 | 0.200 |
| NOx emission factor | lbs/MMBtu | 0.117 | 0.110 | 0.113 |
| CO source concentration | ppmvd | 160.2 | 176.1 | 168.1 |
| CO concentration, M19 conversion | lbs/dscf | 1.165E-05 | 1.279E-05 | 1.222E-05 |
| CO mass rate | lbs/hr | 0.384 | 0.396 | 0.390 |
| NOx emission factor | lbs/MMBtu | 0.218 | 0.224 | 0.221 |

Darby Test, Run 3 Low Fire

| Date/Time mm/dd/yy hh:mm:ss | NOx ppm | O2 % | CO ppm |
|--------------------------------|------------|---------|-----------|
| 02/14/08 08:44:44 | 66.49 | 9.06 | 99.67 |
| 02/14/08 08:44:54 | 65.89 | 9.20 | 106.13 |
| 02/14/08 08:45:04 | 69.17 | 9.07 | 109.48 |
| 02/14/08 08:45:14 | 72.37 | 9.57 | 114.85 |
| 02/14/08 08:45:24 | 70.57 | 9.58 | 105.87 |
| 02/14/08 08:45:34 | 68.86 | 9.29 | 99.34 |
| 02/14/08 08:45:44 | 69.43 | 9.37 | 92.48 |
| 02/14/08 08:45:54 | 70.02 | 9.33 | 88.07 |
| 02/14/08 08:46:04 | 69.41 | 9.10 | 87.49 |
| 02/14/08 08:46:14 | 68.83 | 9.70 | 90.10 |
| 02/14/08 08:46:24 | 68.83 | 9.32 | 92.74 |
| 02/14/08 08:46:34 | 68.89 | 9.61 | 98.76 |
| 02/14/08 08:46:44 | 68.54 | 9.81 | 110.72 |
| 02/14/08 08:46:54 | 68.57 | 10.19 | 120.34 |
| 02/14/08 08:47:04 | 67.31 | 10.83 | 136.84 |
| 02/14/08 08:47:14 | 66.21 | 10.81 | 165.99 |
| 02/14/08 08:47:24 | 62.95 | 10.56 | 181.19 |
| 02/14/08 08:47:34 | 59.56 | 10.68 | 176.35 |
| 02/14/08 08:47:44 | 61.13 | 10.97 | 167.19 |
| 02/14/08 08:47:54 | 62.36 | 10.74 | 158.98 |
| 02/14/08 08:48:04 | 61.14 | 10.98 | 150.55 |
| 02/14/08 08:48:14 | 59.96 | 11.32 | 139.14 |
| 02/14/08 08:48:24 | 59.50 | 10.87 | 141.30 |
| 02/14/08 08:48:34 | 59.19 | 10.83 | 141.57 |
| 02/14/08 08:48:44 | 59.22 | 10.96 | 142.23 |
| 02/14/08 08:48:54 | 59.48 | 10.78 | 139.09 |
| 02/14/08 08:49:04 | 58.94 | 10.32 | 133.56 |
| 02/14/08 08:49:14 | 58.01 | 10.31 | 128.41 |
| 02/14/08 08:49:24 | 61.43 | 10.20 | 115.43 |
| 02/14/08 08:49:34 | 64.65 | 10.57 | 116.05 |
| 02/14/08 08:49:44 | 63.81 | 10.92 | 125.47 |
| 02/14/08 08:49:54 | 62.92 | 11.19 | 129.97 |
| 02/14/08 08:50:04 | 60.25 | 11.10 | 134.14 |
| 02/14/08 08:50:14 | 57.41 | 10.92 | 132.13 |
| 02/14/08 08:50:24 | 58.05 | 10.71 | 129.05 |
| 02/14/08 08:50:34 | 58.93 | 10.49 | 128.46 |
| 02/14/08 08:50:44 | 60.51 | 10.66 | 125.13 |
| 02/14/08 08:50:54 | 62.34 | 10.52 | 133.30 |
| 02/14/08 08:51:04 | 61.74 | 11.10 | 163.66 |
| 02/14/08 08:51:14 | 60.87 | 11.63 | 176.68 |
| 02/14/08 08:51:24 | 57.73 | 11.51 | 184.42 |
| 02/14/08 08:51:34 | 54.84 | 11.68 | 195.09 |
| 02/14/08 08:51:44 | 54.25 | 11.58 | 198.77 |
| 02/14/08 08:51:54 | 53.63 | 11.38 | 182.03 |
| 02/14/08 08:52:04 | 54.25 | 11.29 | 162.82 |
| 02/14/08 08:52:14 | 54.81 | 11.65 | 157.18 |
| 02/14/08 08:52:24 | 54.85 | 11.50 | 151.41 |
| 02/14/08 08:52:34 | 54.85 | 11.48 | 152.01 |
| 02/14/08 08:52:44 | 55.05 | 11.01 | 154.75 |
| 02/14/08 08:52:54 | 55.36 | 11.66 | 154.44 |
| 02/14/08 08:53:04 | 56.54 | 11.59 | 155.08 |
| 02/14/08 08:53:14 | 58.08 | 11.71 | 166.28 |

| | | | |
|-------------------|-------|-------|--------|
| 02/14/08 08:53:24 | 56.25 | 11.53 | 170.49 |
| 02/14/08 08:53:34 | 54.56 | 11.05 | 163.40 |
| 02/14/08 08:53:44 | 55.35 | 11.14 | 148.81 |
| 02/14/08 08:53:54 | 56.56 | 10.85 | 129.68 |
| 02/14/08 08:54:04 | 58.02 | 10.98 | 123.03 |
| 02/14/08 08:54:14 | 59.96 | 11.25 | 133.84 |
| 02/14/08 08:54:24 | 58.36 | 10.83 | 137.43 |
| 02/14/08 08:54:34 | 56.87 | 10.54 | 137.43 |
| 02/14/08 08:54:44 | 58.68 | 10.20 | 128.41 |
| 02/14/08 08:54:54 | 60.56 | 10.06 | 117.13 |
| 02/14/08 08:55:04 | 63.51 | 10.35 | 118.62 |
| 02/14/08 08:55:14 | 66.78 | 11.10 | 129.65 |
| 02/14/08 08:55:24 | 62.66 | 11.07 | 155.11 |
| 02/14/08 08:55:34 | 58.65 | 11.01 | 176.69 |
| 02/14/08 08:55:44 | 57.75 | 10.82 | 188.00 |
| 02/14/08 08:55:54 | 56.87 | 10.93 | 174.26 |
| 02/14/08 08:56:04 | 57.76 | 10.66 | 163.08 |
| 02/14/08 08:56:14 | 58.35 | 10.38 | 157.18 |
| 02/14/08 08:56:24 | 59.51 | 10.18 | 150.86 |
| 02/14/08 08:56:34 | 60.85 | 10.38 | 145.78 |
| 02/14/08 08:56:44 | 62.33 | 10.04 | 126.36 |
| 02/14/08 08:56:54 | 63.52 | 10.21 | 113.36 |
| 02/14/08 08:57:04 | 63.80 | 10.03 | 106.77 |
| 02/14/08 08:57:14 | 63.81 | 9.71 | 104.40 |
| 02/14/08 08:57:24 | 65.56 | 9.46 | 107.38 |
| 02/14/08 08:57:34 | 67.32 | 9.26 | 106.76 |
| 02/14/08 08:57:44 | 68.85 | 9.27 | 107.74 |
| 02/14/08 08:57:54 | 70.03 | 9.62 | 111.95 |
| 02/14/08 08:58:04 | 69.70 | 9.96 | 119.78 |
| 02/14/08 08:58:14 | 69.14 | 9.58 | 117.16 |
| 02/14/08 08:58:24 | 67.96 | 9.75 | 111.67 |
| 02/14/08 08:58:34 | 66.76 | 9.67 | 103.84 |
| 02/14/08 08:58:44 | 67.06 | 9.26 | 100.28 |
| 02/14/08 08:58:54 | 67.04 | 9.70 | 108.28 |
| 02/14/08 08:59:04 | 67.95 | 10.12 | 113.07 |
| 02/14/08 08:59:14 | 68.82 | 10.40 | 122.18 |
| 02/14/08 08:59:24 | 66.78 | 10.61 | 125.42 |
| 02/14/08 08:59:34 | 65.00 | 10.77 | 133.56 |
| 02/14/08 08:59:44 | 62.63 | 10.67 | 140.05 |
| 02/14/08 08:59:54 | 60.24 | 10.25 | 145.71 |
| 02/14/08 09:00:04 | 61.72 | 10.32 | 152.32 |
| 02/14/08 09:00:14 | 62.91 | 10.71 | 162.17 |
| 02/14/08 09:00:24 | 61.40 | 10.51 | 159.94 |
| 02/14/08 09:00:34 | 60.23 | 10.02 | 154.50 |
| 02/14/08 09:00:44 | 61.74 | 10.29 | 144.92 |
| 02/14/08 09:00:54 | 63.21 | 10.32 | 130.24 |
| 02/14/08 09:01:04 | 62.62 | 10.42 | 131.80 |
| 02/14/08 09:01:14 | 62.08 | 11.14 | 145.20 |
| 02/14/08 09:01:24 | 60.55 | 11.08 | 151.43 |
| 02/14/08 09:01:34 | 58.63 | 11.35 | 161.10 |
| 02/14/08 09:01:44 | 57.13 | 12.14 | 168.00 |
| 02/14/08 09:01:54 | 55.65 | 12.63 | 188.57 |
| 02/14/08 09:02:04 | 52.75 | 12.21 | 292.15 |
| 02/14/08 09:02:14 | 50.05 | 11.70 | 323.24 |
| 02/14/08 09:02:24 | 49.75 | 11.49 | 317.59 |
| 02/14/08 09:02:34 | 49.11 | 11.30 | 271.02 |
| 02/14/08 09:02:44 | 49.72 | 10.84 | 255.53 |
| 02/14/08 09:02:54 | 50.37 | 10.79 | 278.12 |

| | | | |
|-------------------|-------|-------|--------|
| 02/14/08 09:03:04 | 53.07 | 11.55 | 296.70 |
| 02/14/08 09:03:14 | 55.65 | 11.56 | 305.16 |
| 02/14/08 09:03:24 | 52.77 | 11.71 | 280.80 |
| 02/14/08 09:03:34 | 49.75 | 12.42 | 240.20 |
| 02/14/08 09:03:44 | 50.30 | 12.64 | 207.13 |
| 02/14/08 09:03:54 | 50.66 | 12.58 | 188.58 |
| 02/14/08 09:04:04 | 48.53 | 12.94 | 185.55 |
| 02/14/08 09:04:14 | 46.49 | 13.10 | 188.83 |
| 02/14/08 09:04:24 | 46.47 | 13.77 | 192.67 |
| 02/14/08 09:04:34 | 46.77 | 13.48 | 183.47 |
| 02/14/08 09:04:44 | 45.00 | 13.65 | 179.90 |
| 02/14/08 09:04:54 | 43.24 | 13.95 | 172.42 |
| 02/14/08 09:05:04 | 42.69 | 13.24 | 181.98 |
| 02/14/08 09:05:14 | 42.33 | 13.88 | 198.67 |
| 02/14/08 09:05:24 | 43.50 | 14.21 | 205.01 |
| 02/14/08 09:05:34 | 44.71 | 14.07 | 219.34 |
| 02/14/08 09:05:44 | 42.03 | 14.57 | 229.54 |
| 02/14/08 09:05:54 | 39.68 | 14.34 | 225.06 |
| 02/14/08 09:06:04 | 39.36 | 14.53 | 214.24 |
| 02/14/08 09:06:14 | 39.07 | 14.71 | 195.41 |
| 02/14/08 09:06:24 | 38.71 | 14.87 | 174.59 |
| 02/14/08 09:06:34 | 38.74 | 14.34 | 159.56 |
| 02/14/08 09:06:44 | 38.44 | 14.39 | 182.04 |
| 02/14/08 09:06:54 | 38.24 | 14.69 | 181.11 |
| 02/14/08 09:07:04 | 37.91 | 14.59 | 171.55 |
| 02/14/08 09:07:14 | 37.84 | 14.21 | 178.98 |
| 02/14/08 09:07:24 | 38.47 | 14.51 | 189.11 |
| 02/14/08 09:07:34 | 38.99 | 14.04 | 195.39 |
| 02/14/08 09:07:44 | 39.68 | 14.12 | 225.33 |
| 02/14/08 09:07:54 | 40.23 | 14.10 | 225.89 |
| 02/14/08 09:08:04 | 40.88 | 14.26 | 219.41 |
| 02/14/08 09:08:14 | 41.16 | 14.67 | 191.48 |
| 02/14/08 09:08:24 | 40.20 | 14.08 | 174.28 |
| 02/14/08 09:08:34 | 39.05 | 13.79 | 183.43 |
| 02/14/08 09:08:44 | 40.25 | 13.95 | 196.31 |
| 02/14/08 09:08:54 | 41.47 | 13.87 | 190.00 |
| 02/14/08 09:09:04 | 41.45 | 14.22 | 173.68 |
| 02/14/08 09:09:14 | 41.44 | 14.38 | 180.49 |
| 02/14/08 09:09:24 | 40.50 | 13.84 | 205.27 |
| 02/14/08 09:09:34 | 39.99 | 13.88 | 243.91 |
| 02/14/08 09:09:44 | 41.18 | 14.19 | 229.55 |
| 02/14/08 09:09:54 | 42.36 | 14.32 | 212.78 |
| 02/14/08 09:10:04 | 41.12 | 14.11 | 201.12 |
| 02/14/08 09:10:14 | 39.92 | 13.75 | 208.30 |
| 02/14/08 09:10:24 | 40.27 | 13.27 | 215.70 |
| 02/14/08 09:10:34 | 40.91 | 13.23 | 207.75 |
| 02/14/08 09:10:44 | 42.33 | 13.87 | 206.17 |
| 02/14/08 09:10:54 | 44.13 | 13.78 | 197.19 |
| 02/14/08 09:11:04 | 43.25 | 14.17 | 198.70 |
| 02/14/08 09:11:14 | 42.33 | 13.58 | 206.22 |
| 02/14/08 09:11:24 | 42.66 | 13.99 | 226.58 |
| 02/14/08 09:11:34 | 43.24 | 14.12 | 218.14 |
| 02/14/08 09:11:44 | 42.38 | 14.32 | 227.81 |
| 02/14/08 09:11:54 | 41.12 | 14.25 | 243.30 |
| 02/14/08 09:12:04 | 40.26 | 14.27 | 257.69 |
| 02/14/08 09:12:14 | 39.05 | 13.77 | 253.16 |
| 02/14/08 09:12:24 | 39.35 | 13.92 | 239.88 |
| 02/14/08 09:12:34 | 39.69 | 13.96 | 219.62 |

| | | | |
|-------------------|-------|-------|--------|
| 02/14/08 09:12:44 | 40.56 | 13.82 | 246.70 |
| 02/14/08 09:12:54 | 41.43 | 13.84 | 245.80 |
| 02/14/08 09:13:04 | 41.75 | 13.72 | 236.11 |
| 02/14/08 09:13:14 | 42.41 | 13.82 | 225.96 |
| 02/14/08 09:13:24 | 42.65 | 13.56 | 218.47 |
| 02/14/08 09:13:34 | 42.90 | 13.97 | 222.30 |
| 02/14/08 09:13:44 | 42.96 | 13.95 | 231.58 |
| 02/14/08 09:13:54 | 43.19 | 13.91 | 229.51 |
| 02/14/08 09:14:04 | 42.09 | 13.49 | 233.10 |
| 02/14/08 09:14:14 | 41.14 | 13.40 | 244.21 |
| 02/14/08 09:14:24 | 41.45 | 13.30 | 244.80 |
| 02/14/08 09:14:34 | 41.80 | 13.07 | 254.05 |
| 02/14/08 09:14:44 | 42.94 | 12.90 | 260.67 |
| 02/14/08 09:14:54 | 43.87 | 12.45 | 262.52 |
| 02/14/08 09:15:04 | 44.43 | 12.28 | 250.64 |
| 02/14/08 09:15:14 | 45.03 | 12.33 | 244.81 |
| 02/14/08 09:15:24 | 46.74 | 12.64 | 243.04 |
| 02/14/08 09:15:34 | 48.57 | 11.93 | 257.94 |
| 02/14/08 09:15:44 | 49.13 | 12.49 | 278.09 |
| 02/14/08 09:15:54 | 49.74 | 12.70 | 281.30 |
| 02/14/08 09:16:04 | 48.25 | 12.53 | 291.20 |
| 02/14/08 09:16:14 | 46.79 | 11.77 | 264.84 |
| 02/14/08 09:16:24 | 47.97 | 11.47 | 236.70 |
| 02/14/08 09:16:34 | 48.83 | 11.20 | 218.97 |
| 02/14/08 09:16:44 | 52.11 | 11.96 | 198.69 |
| 02/14/08 09:16:54 | 55.07 | 11.95 | 178.45 |
| 02/14/08 09:17:04 | 53.64 | 11.71 | 161.96 |
| 02/14/08 09:17:14 | 51.84 | 12.24 | 154.71 |
| 02/14/08 09:17:24 | 52.42 | 11.90 | 163.01 |
| 02/14/08 09:17:34 | 52.70 | 11.71 | 175.46 |
| 02/14/08 09:17:44 | 52.15 | 11.55 | 179.30 |
| 02/14/08 09:17:54 | 51.18 | 11.53 | 182.30 |
| 02/14/08 09:18:04 | 53.07 | 11.81 | 185.25 |
| 02/14/08 09:18:14 | 54.82 | 11.73 | 179.61 |
| 02/14/08 09:18:24 | 53.94 | 11.92 | 166.59 |
| 02/14/08 09:18:34 | 53.07 | 11.52 | 157.47 |
| 02/14/08 09:18:44 | 53.63 | 11.29 | 148.16 |
| 02/14/08 09:18:54 | 54.23 | 10.76 | 149.59 |
| 02/14/08 09:19:04 | 56.57 | 10.89 | 152.00 |
| 02/14/08 09:19:14 | 58.94 | 10.98 | 149.65 |
| 02/14/08 09:19:24 | 58.95 | 10.69 | 145.75 |
| 02/14/08 09:19:34 | 58.96 | 10.86 | 141.88 |
| 02/14/08 09:19:44 | 59.52 | 10.88 | 158.96 |
| 02/14/08 09:19:54 | 59.97 | 10.84 | 180.46 |
| 02/14/08 09:20:04 | 58.35 | 10.57 | 208.60 |
| 02/14/08 09:20:14 | 56.60 | 10.73 | 240.65 |
| 02/14/08 09:20:24 | 56.84 | 10.97 | 260.68 |
| 02/14/08 09:20:34 | 57.20 | 11.55 | 238.13 |
| 02/14/08 09:20:44 | 57.15 | 11.73 | 213.66 |
| 02/14/08 09:20:54 | 57.20 | 11.72 | 188.80 |
| 02/14/08 09:21:04 | 54.55 | 11.08 | 171.38 |
| 02/14/08 09:21:14 | 52.14 | 11.55 | 160.80 |
| 02/14/08 09:21:24 | 53.94 | 11.46 | 158.09 |
| 02/14/08 09:21:34 | 55.99 | 11.54 | 157.77 |
| 02/14/08 09:21:44 | 54.86 | 11.79 | 158.08 |
| 02/14/08 09:21:54 | 53.68 | 12.11 | 161.69 |
| 02/14/08 09:22:04 | 53.96 | 12.27 | 174.88 |
| 02/14/08 09:22:14 | 53.93 | 12.19 | 196.57 |

| | | | |
|-------------------|--------------|--------------|---------------|
| 02/14/08 09:22:24 | 52.43 | 11.43 | 219.93 |
| 02/14/08 09:22:34 | 51.25 | 11.36 | 222.05 |
| 02/14/08 09:22:44 | 52.40 | 11.29 | 204.39 |
| 02/14/08 09:22:54 | 53.33 | 11.06 | 190.32 |
| 02/14/08 09:23:04 | 55.03 | 11.12 | 177.28 |
| 02/14/08 09:23:14 | 56.56 | 10.99 | 170.18 |
| 02/14/08 09:23:24 | 56.88 | 10.72 | 170.46 |
| 02/14/08 09:23:34 | 57.13 | 10.72 | 155.95 |
| 02/14/08 09:23:44 | 58.61 | 10.71 | 148.43 |
| 02/14/08 09:23:54 | 60.24 | 11.20 | 149.64 |
| 02/14/08 09:24:04 | 59.54 | 11.18 | 158.07 |
| 02/14/08 09:24:14 | 58.62 | 11.46 | 148.80 |
| 02/14/08 09:24:24 | 57.74 | 11.21 | 142.81 |
| 02/14/08 09:24:34 | 57.14 | 10.97 | 141.02 |
| 02/14/08 09:24:44 | 58.91 | 11.15 | 155.64 |
| 02/14/08 09:24:54 | 60.79 | 11.23 | 171.07 |
| 02/14/08 09:25:04 | 59.51 | 11.22 | 183.48 |
| AVERAGE > | 53.98 | 11.75 | 176.70 |

Darby Test, Run 4 Low Fire

| Date/Time mm/dd/yy hh:mm:ss | NOx ppm | O2 % | CO ppm |
|--------------------------------|------------|---------|-----------|
| 02/14/08 09:41:24 | 45.00 | 14.45 | 227.16 |
| 02/14/08 09:41:34 | 45.01 | 14.66 | 208.28 |
| 02/14/08 09:41:44 | 42.92 | 14.76 | 184.34 |
| 02/14/08 09:41:54 | 40.54 | 14.08 | 198.45 |
| 02/14/08 09:42:04 | 40.19 | 14.03 | 213.91 |
| 02/14/08 09:45:44 | 50.95 | 12.39 | 192.36 |
| 02/14/08 09:45:54 | 51.18 | 12.39 | 202.91 |
| 02/14/08 09:46:04 | 51.47 | 12.85 | 203.55 |
| 02/14/08 09:46:14 | 51.80 | 13.00 | 205.90 |
| 02/14/08 09:46:24 | 49.70 | 12.33 | 205.60 |
| 02/14/08 09:46:34 | 47.91 | 12.30 | 209.12 |
| 02/14/08 09:46:44 | 49.70 | 12.36 | 223.21 |
| 02/14/08 09:46:54 | 51.44 | 11.86 | 233.38 |
| 02/14/08 09:47:04 | 50.60 | 11.99 | 228.62 |
| 02/14/08 09:47:14 | 49.95 | 11.44 | 215.11 |
| 02/14/08 09:47:24 | 52.02 | 11.28 | 186.15 |
| 02/14/08 09:47:34 | 54.12 | 11.57 | 172.43 |
| 02/14/08 09:47:44 | 55.02 | 11.15 | 172.45 |
| 02/14/08 09:47:54 | 55.90 | 11.65 | 174.28 |
| 02/14/08 09:48:04 | 58.02 | 11.75 | 185.84 |
| 02/14/08 09:48:14 | 60.19 | 11.77 | 198.41 |
| 02/14/08 09:48:24 | 57.63 | 11.50 | 192.97 |
| 02/14/08 09:48:34 | 55.31 | 11.25 | 183.46 |
| 02/14/08 09:48:44 | 57.09 | 11.10 | 168.34 |
| 02/14/08 09:48:54 | 58.88 | 11.19 | 152.32 |
| 02/14/08 09:49:04 | 59.90 | 10.99 | 144.59 |
| 02/14/08 09:49:14 | 61.08 | 10.40 | 141.57 |
| 02/14/08 09:49:24 | 62.90 | 10.56 | 138.74 |
| 02/14/08 09:49:34 | 64.90 | 10.61 | 139.96 |
| 02/14/08 09:49:44 | 64.09 | 11.02 | 145.73 |
| 02/14/08 09:49:54 | 62.85 | 11.17 | 140.30 |
| 02/14/08 09:50:04 | 61.37 | 11.35 | 136.47 |
| 02/14/08 09:50:14 | 59.48 | 11.23 | 151.41 |
| 02/14/08 09:50:24 | 58.54 | 11.08 | 168.34 |
| 02/14/08 09:50:34 | 57.36 | 11.26 | 159.27 |
| 02/14/08 09:50:44 | 58.89 | 10.98 | 150.82 |
| 02/14/08 09:50:54 | 60.16 | 10.79 | 150.45 |
| 02/14/08 09:51:04 | 61.96 | 10.55 | 155.33 |
| 02/14/08 09:51:14 | 63.44 | 10.23 | 152.23 |
| 02/14/08 09:51:24 | 65.54 | 10.30 | 146.31 |
| 02/14/08 09:51:34 | 67.27 | 10.74 | 146.33 |
| 02/14/08 09:51:44 | 66.12 | 11.17 | 140.98 |
| 02/14/08 09:51:54 | 65.23 | 11.02 | 145.21 |
| 02/14/08 09:52:04 | 62.83 | 10.68 | 151.68 |
| 02/14/08 09:52:14 | 60.54 | 11.09 | 161.61 |
| 02/14/08 09:52:24 | 60.19 | 10.80 | 173.02 |
| 02/14/08 09:52:34 | 59.87 | 11.07 | 166.55 |
| 02/14/08 09:52:44 | 60.79 | 11.28 | 161.95 |
| 02/14/08 09:52:54 | 61.62 | 11.34 | 159.26 |
| 02/14/08 09:53:04 | 59.47 | 11.40 | 163.93 |
| 02/14/08 09:53:14 | 57.06 | 11.28 | 191.14 |
| 02/14/08 09:53:24 | 58.30 | 11.39 | 200.51 |

| | | | |
|-------------------|-------|-------|--------|
| 02/14/08 09:53:34 | 59.50 | 11.04 | 197.46 |
| 02/14/08 09:53:44 | 59.18 | 10.74 | 175.72 |
| 02/14/08 09:53:54 | 58.51 | 10.74 | 156.85 |
| 02/14/08 09:54:04 | 60.50 | 11.29 | 155.05 |
| 02/14/08 09:54:14 | 61.97 | 11.41 | 165.37 |
| 02/14/08 09:54:24 | 60.19 | 11.36 | 175.68 |
| 02/14/08 09:54:34 | 57.95 | 11.30 | 170.98 |
| 02/14/08 09:54:44 | 57.66 | 11.60 | 171.80 |
| 02/14/08 09:54:54 | 57.38 | 11.10 | 185.86 |
| 02/14/08 09:55:04 | 57.09 | 10.93 | 189.09 |
| 02/14/08 09:55:14 | 56.50 | 10.82 | 182.54 |
| 02/14/08 09:55:24 | 58.03 | 10.26 | 156.83 |
| 02/14/08 09:55:34 | 59.14 | 10.50 | 135.91 |
| 02/14/08 09:55:44 | 62.57 | 10.57 | 123.02 |
| 02/14/08 09:55:54 | 65.83 | 10.36 | 123.91 |
| 02/14/08 09:56:04 | 66.46 | 10.32 | 130.20 |
| 02/14/08 09:56:14 | 66.95 | 10.46 | 127.46 |
| 02/14/08 09:56:24 | 66.08 | 10.67 | 121.22 |
| 02/14/08 09:56:34 | 65.50 | 10.87 | 121.24 |
| 02/14/08 09:56:44 | 0.00 | 0.00 | 0.00 |
| 02/14/08 09:57:14 | 59.87 | 11.29 | 135.00 |
| 02/14/08 09:57:24 | 58.32 | 11.46 | 138.01 |
| 02/14/08 09:57:34 | 57.07 | 11.65 | 135.90 |
| 02/14/08 09:57:44 | 57.08 | 11.58 | 144.00 |
| 02/14/08 09:57:54 | 57.06 | 11.73 | 148.14 |
| 02/14/08 09:58:04 | 56.49 | 11.26 | 143.09 |
| 02/14/08 09:58:14 | 55.91 | 11.18 | 138.80 |
| 02/14/08 09:58:24 | 57.91 | 11.26 | 143.97 |
| 02/14/08 09:58:34 | 59.86 | 11.43 | 154.10 |
| 02/14/08 09:58:44 | 59.16 | 10.51 | 157.16 |
| 02/14/08 09:58:54 | 58.26 | 10.72 | 138.25 |
| 02/14/08 09:59:04 | 61.95 | 10.75 | 121.83 |
| 02/14/08 09:59:14 | 65.23 | 10.82 | 122.11 |
| 02/14/08 09:59:24 | 64.36 | 11.09 | 130.50 |
| 02/14/08 09:59:34 | 63.47 | 11.06 | 143.43 |
| 02/14/08 09:59:44 | 62.25 | 10.40 | 151.68 |
| 02/14/08 09:59:54 | 60.79 | 10.87 | 156.55 |
| 02/14/08 10:00:04 | 62.86 | 11.68 | 161.07 |
| 02/14/08 10:00:14 | 64.61 | 11.92 | 177.83 |
| 02/14/08 10:00:24 | 59.85 | 11.90 | 201.12 |
| 02/14/08 10:00:34 | 55.02 | 12.59 | 219.90 |
| 02/14/08 10:00:44 | 52.98 | 12.85 | 226.20 |
| 02/14/08 10:00:54 | 50.90 | 13.35 | 200.27 |
| 02/14/08 10:01:04 | 48.49 | 13.61 | 175.09 |
| 02/14/08 10:01:14 | 46.45 | 13.17 | 166.82 |
| 02/14/08 10:01:24 | 45.27 | 12.73 | 175.73 |
| 02/14/08 10:01:34 | 43.77 | 12.74 | 184.92 |
| 02/14/08 10:01:44 | 46.14 | 12.43 | 196.84 |
| 02/14/08 10:01:54 | 48.54 | 12.21 | 203.78 |
| 02/14/08 10:02:04 | 49.96 | 11.41 | 203.18 |
| 02/14/08 10:02:14 | 51.17 | 11.99 | 199.55 |
| 02/14/08 10:02:24 | 53.57 | 11.75 | 260.08 |
| 02/14/08 10:02:34 | 55.89 | 11.74 | 250.61 |
| 02/14/08 10:02:44 | 55.25 | 12.23 | 220.45 |
| 02/14/08 10:02:54 | 54.49 | 12.55 | 203.18 |
| 02/14/08 10:03:04 | 53.00 | 12.78 | 207.04 |
| 02/14/08 10:03:14 | 51.51 | 12.58 | 219.30 |
| 02/14/08 10:03:24 | 50.26 | 12.69 | 237.18 |

| | | | |
|-------------------|-------|-------|--------|
| 02/14/08 10:03:34 | 49.36 | 13.07 | 236.34 |
| 02/14/08 10:03:44 | 47.88 | 13.24 | 233.95 |
| 02/14/08 10:03:54 | 46.44 | 13.78 | 216.30 |
| 02/14/08 10:04:04 | 46.11 | 13.59 | 212.67 |
| 02/14/08 10:04:14 | 45.82 | 14.19 | 199.24 |
| 02/14/08 10:04:24 | 44.37 | 13.70 | 191.43 |
| 02/14/08 10:04:34 | 42.57 | 13.29 | 190.88 |
| 02/14/08 10:04:44 | 43.78 | 12.88 | 178.40 |
| 02/14/08 10:04:54 | 44.65 | 12.70 | 171.82 |
| 02/14/08 10:05:04 | 46.42 | 12.58 | 190.22 |
| 02/14/08 10:05:14 | 47.88 | 12.64 | 227.71 |
| 02/14/08 10:05:24 | 48.18 | 12.85 | 253.13 |
| 02/14/08 10:05:34 | 48.52 | 12.82 | 248.14 |
| 02/14/08 10:05:44 | 47.60 | 12.71 | 222.87 |
| 02/14/08 10:05:54 | 46.46 | 12.46 | 191.43 |
| 02/14/08 10:06:04 | 48.18 | 12.34 | 177.50 |
| 02/14/08 10:06:14 | 49.69 | 12.66 | 187.30 |
| 02/14/08 10:06:24 | 49.70 | 12.64 | 209.70 |
| 02/14/08 10:06:34 | 50.01 | 13.08 | 238.89 |
| 02/14/08 10:06:44 | 48.51 | 13.30 | 225.58 |
| 02/14/08 10:06:54 | 47.31 | 13.55 | 200.24 |
| 02/14/08 10:07:04 | 46.12 | 13.56 | 186.68 |
| 02/14/08 10:07:14 | 44.96 | 13.72 | 178.64 |
| 02/14/08 10:07:24 | 44.65 | 14.10 | 175.68 |
| 02/14/08 10:07:34 | 44.42 | 14.31 | 176.62 |
| 02/14/08 10:07:44 | 43.50 | 14.23 | 182.52 |
| 02/14/08 10:07:54 | 42.29 | 14.14 | 188.52 |
| 02/14/08 10:08:04 | 41.74 | 14.11 | 198.92 |
| 02/14/08 10:08:14 | 41.39 | 13.83 | 209.78 |
| 02/14/08 10:08:24 | 41.99 | 13.50 | 221.98 |
| 02/14/08 10:08:34 | 42.93 | 13.33 | 216.92 |
| 02/14/08 10:08:44 | 43.81 | 12.75 | 207.02 |
| 02/14/08 10:08:54 | 44.68 | 12.45 | 205.86 |
| 02/14/08 10:09:04 | 47.05 | 12.39 | 209.70 |
| 02/14/08 10:09:14 | 49.08 | 11.63 | 224.15 |
| 02/14/08 10:09:24 | 49.75 | 11.54 | 229.21 |
| 02/14/08 10:09:34 | 50.31 | 11.80 | 205.83 |
| 02/14/08 10:09:44 | 52.70 | 12.07 | 185.79 |
| 02/14/08 10:09:54 | 54.80 | 12.17 | 177.80 |
| 02/14/08 10:10:04 | 52.40 | 11.91 | 190.51 |
| 02/14/08 10:10:14 | 50.29 | 11.83 | 195.34 |
| 02/14/08 10:10:24 | 51.45 | 11.66 | 217.22 |
| 02/14/08 10:10:34 | 52.70 | 11.32 | 220.20 |
| 02/14/08 10:10:44 | 53.29 | 11.29 | 208.82 |
| 02/14/08 10:10:54 | 53.91 | 11.11 | 194.44 |
| 02/14/08 10:11:04 | 55.89 | 11.07 | 201.12 |
| 02/14/08 10:11:14 | 57.67 | 10.93 | 230.08 |
| 02/14/08 10:11:24 | 58.34 | 10.92 | 237.52 |
| 02/14/08 10:11:34 | 58.56 | 10.92 | 240.39 |
| 02/14/08 10:11:44 | 58.29 | 11.17 | 233.31 |
| 02/14/08 10:11:54 | 57.97 | 11.04 | 223.79 |
| 02/14/08 10:12:04 | 57.69 | 11.62 | 207.38 |
| 02/14/08 10:12:14 | 57.68 | 11.47 | 212.41 |
| 02/14/08 10:12:24 | 54.79 | 11.44 | 230.64 |
| 02/14/08 10:12:34 | 51.79 | 11.59 | 221.43 |
| 02/14/08 10:12:44 | 52.72 | 11.76 | 214.76 |
| 02/14/08 10:12:54 | 53.93 | 11.24 | 195.70 |
| 02/14/08 10:13:04 | 54.46 | 11.09 | 172.37 |

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|-------------------|-------|-------|--------|
| 02/14/08 10:13:14 | 55.05 | 10.57 | 148.70 |
| 02/14/08 10:13:24 | 56.51 | 10.62 | 134.67 |
| 02/14/08 10:13:34 | 58.30 | 10.35 | 122.72 |
| 02/14/08 10:13:44 | 60.51 | 10.75 | 130.21 |
| 02/14/08 10:13:54 | 62.58 | 10.86 | 162.08 |
| 02/14/08 10:14:04 | 60.51 | 10.82 | 200.51 |
| 02/14/08 10:14:14 | 58.28 | 10.96 | 199.52 |
| 02/14/08 10:14:24 | 58.34 | 10.97 | 177.47 |
| 02/14/08 10:14:34 | 58.28 | 10.96 | 168.85 |
| 02/14/08 10:14:44 | 57.99 | 11.24 | 173.27 |
| 02/14/08 10:14:54 | 57.98 | 11.26 | 198.38 |
| 02/14/08 10:15:04 | 55.92 | 11.29 | 215.95 |
| 02/14/08 10:15:14 | 54.18 | 10.66 | 211.74 |
| 02/14/08 10:15:24 | 55.32 | 10.70 | 205.81 |
| 02/14/08 10:15:34 | 56.52 | 11.04 | 194.42 |
| 02/14/08 10:15:44 | 57.37 | 11.75 | 200.82 |
| 02/14/08 10:15:54 | 58.31 | 12.03 | 201.93 |
| 02/14/08 10:16:04 | 55.01 | 11.87 | 200.50 |
| 02/14/08 10:16:14 | 51.79 | 11.67 | 180.11 |
| 02/14/08 10:16:24 | 51.46 | 11.86 | 159.24 |
| 02/14/08 10:16:34 | 51.47 | 12.38 | 142.43 |
| 02/14/08 10:16:44 | 51.48 | 12.10 | 131.74 |
| 02/14/08 10:16:54 | 51.75 | 12.23 | 125.66 |
| 02/14/08 10:17:04 | 51.78 | 11.48 | 129.56 |
| 02/14/08 10:17:14 | 51.82 | 11.76 | 132.95 |
| 02/14/08 10:17:24 | 53.90 | 11.63 | 139.36 |
| 02/14/08 10:17:34 | 55.88 | 11.19 | 149.88 |
| 02/14/08 10:17:44 | 56.22 | 11.39 | 159.51 |
| 02/14/08 10:17:54 | 56.52 | 11.58 | 172.41 |
| 02/14/08 10:18:04 | 55.65 | 11.16 | 201.67 |
| 02/14/08 10:18:14 | 54.76 | 11.53 | 227.11 |
| 02/14/08 10:18:24 | 54.76 | 11.85 | 234.55 |
| 02/14/08 10:18:34 | 55.01 | 12.67 | 222.00 |
| 02/14/08 10:18:44 | 52.97 | 12.49 | 198.04 |
| 02/14/08 10:18:54 | 50.90 | 12.68 | 185.20 |
| 02/14/08 10:19:04 | 49.72 | 13.18 | 169.27 |
| 02/14/08 10:19:14 | 48.81 | 13.26 | 161.89 |
| 02/14/08 10:19:24 | 47.38 | 13.06 | 169.82 |
| 02/14/08 10:19:34 | 45.88 | 12.97 | 181.07 |
| 02/14/08 10:19:44 | 45.53 | 12.63 | 186.41 |
| 02/14/08 10:19:54 | 45.27 | 12.20 | 199.25 |
| 02/14/08 10:20:04 | 46.10 | 12.34 | 213.27 |
| 02/14/08 10:20:14 | 46.75 | 12.14 | 208.79 |
| 02/14/08 10:20:24 | 47.86 | 12.40 | 210.30 |
| 02/14/08 10:20:34 | 49.40 | 11.82 | 213.88 |
| 02/14/08 10:20:44 | 50.00 | 11.50 | 222.55 |
| 02/14/08 10:20:54 | 50.89 | 11.65 | 230.64 |
| 02/14/08 10:21:04 | 52.34 | 12.33 | 229.73 |
| 02/14/08 10:21:14 | 53.93 | 13.03 | 210.24 |
| 02/14/08 10:21:24 | 50.93 | 13.00 | 178.64 |
| 02/14/08 10:21:34 | 47.95 | 12.75 | 155.91 |
| 02/14/08 10:21:44 | 47.04 | 12.27 | 154.99 |
| 02/14/08 10:21:54 | 46.14 | 11.90 | 151.05 |
| 02/14/08 10:22:04 | 48.25 | 11.54 | 143.39 |
| 02/14/08 10:22:14 | 50.57 | 11.55 | 132.92 |
| 02/14/08 10:22:24 | 52.98 | 11.42 | 143.04 |
| 02/14/08 10:22:34 | 55.03 | 11.03 | 157.12 |
| 02/14/08 10:22:44 | 55.61 | 11.24 | 192.33 |

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|---------------------|-------|--------------|---------------|
| 02/14/08 10:22:54 | 56.23 | 11.72 | 226.47 |
| 02/14/08 10:23:04 | 54.47 | 11.91 | 231.25 |
| 02/14/08 10:23:14 | 52.69 | 12.40 | 209.72 |
| 02/14/08 10:23:24 | 51.47 | 13.01 | 198.02 |
| 02/14/08 10:23:34 | 50.26 | 12.67 | 192.33 |
| 02/14/08 10:23:44 | 48.19 | 12.15 | 192.92 |
| 02/14/08 10:23:54 | 45.85 | 11.91 | 191.71 |
| 02/14/08 10:24:04 | 47.88 | 11.72 | 182.23 |
| 02/14/08 10:24:14 | 49.99 | 11.23 | 192.97 |
| 02/14/08 10:24:24 | 51.79 | 11.40 | 192.61 |
| 02/14/08 10:24:34 | 53.29 | 10.60 | 194.39 |
| 02/14/08 10:24:44 | 54.77 | 10.73 | 198.92 |
| 02/14/08 10:24:54 | 55.91 | 10.93 | 194.75 |
| 02/14/08 10:25:04 | 56.52 | 10.99 | 193.82 |
| 02/14/08 10:25:14 | 57.38 | 11.19 | 194.42 |
| 02/14/08 10:25:24 | 56.50 | 11.10 | 187.90 |
| 02/14/08 10:25:34 | 55.61 | 10.91 | 185.17 |
| 02/14/08 10:25:44 | 56.23 | 10.91 | 175.96 |
| 02/14/08 10:25:54 | 56.79 | 10.78 | 175.07 |
| 02/14/08 10:26:04 | 56.18 | 10.76 | 181.93 |
| 02/14/08 10:26:14 | 55.64 | 10.53 | 189.07 |
| 02/14/08 10:26:24 | 56.24 | 10.75 | 205.24 |
| 02/14/08 10:26:34 | 57.17 | 11.11 | 208.57 |
| 02/14/08 10:26:44 | 56.23 | 11.09 | 207.95 |
| 02/14/08 10:26:54 | 55.34 | 10.77 | 199.49 |
| 02/14/08 10:27:04 | 55.33 | 11.03 | 187.32 |
| 02/14/08 10:27:14 | 55.69 | 10.65 | 176.32 |
| 02/14/08 10:27:24 | 55.03 | 10.76 | 201.66 |
| 02/14/08 10:27:34 | 54.50 | 10.67 | 213.84 |
| 02/14/08 10:27:44 | 54.77 | 10.20 | 224.40 |
| 02/14/08 10:27:54 | 55.35 | 10.67 | 214.47 |
| 02/14/08 10:28:04 | 57.20 | 11.18 | 201.39 |
| 02/14/08 10:28:14 | 59.17 | 11.03 | 184.62 |
| 02/14/08 10:28:24 | 56.51 | 10.99 | 169.84 |
| 02/14/08 10:28:34 | 54.15 | 10.71 | 155.27 |
| 02/14/08 10:28:44 | 55.65 | 10.92 | 156.77 |
| 02/14/08 10:28:54 | 56.85 | 11.00 | 179.18 |
| 02/14/08 10:29:04 | 55.88 | 11.25 | 210.87 |
| 02/14/08 10:29:14 | 54.79 | 11.72 | 213.29 |
| AVERAGE > | | 54.12 | 11.66 |
| | | | 183.57 |

Darby Test, Run 5 Low Fire

| Date/Time mm/dd/yy hh:mm:ss | NOx ppm | O2 % | CO ppm |
|--------------------------------|------------|---------|-----------|
| 02/14/08 11:02:44 | 40.85 | 14.87 | 95.76 |
| 02/14/08 11:02:54 | 41.69 | 15.20 | 102.04 |
| 02/14/08 11:03:04 | 41.69 | 15.37 | 112.37 |
| 02/14/08 11:03:14 | 41.71 | 15.81 | 112.72 |
| 02/14/08 11:03:24 | 40.17 | 15.14 | 127.48 |
| 02/14/08 11:03:34 | 38.45 | 14.18 | 216.50 |
| 02/14/08 11:03:44 | 41.11 | 14.16 | 227.39 |
| 02/14/08 11:03:54 | 43.44 | 14.30 | 226.82 |
| 02/14/08 11:04:04 | 44.10 | 14.38 | 193.83 |
| 02/14/08 11:04:14 | 44.36 | 14.55 | 175.38 |
| 02/14/08 11:04:24 | 42.58 | 14.58 | 172.95 |
| 02/14/08 11:04:34 | 40.47 | 14.22 | 168.63 |
| 02/14/08 11:04:44 | 41.13 | 14.03 | 175.97 |
| 02/14/08 11:04:54 | 41.39 | 14.19 | 181.34 |
| 02/14/08 11:05:04 | 42.60 | 14.28 | 161.92 |
| 02/14/08 11:05:14 | 43.75 | 13.64 | 182.55 |
| 02/14/08 11:05:24 | 43.80 | 13.73 | 203.46 |
| 02/14/08 11:05:34 | 44.04 | 13.34 | 227.71 |
| 02/14/08 11:05:44 | 44.97 | 13.54 | 225.56 |
| 02/14/08 11:05:54 | 46.13 | 13.85 | 199.85 |
| 02/14/08 11:06:04 | 45.52 | 13.92 | 170.70 |
| 02/14/08 11:06:14 | 45.29 | 13.43 | 149.89 |
| 02/14/08 11:06:24 | 45.31 | 13.33 | 160.37 |
| 02/14/08 11:06:34 | 45.33 | 13.08 | 163.30 |
| 02/14/08 11:06:44 | 46.18 | 13.11 | 192.29 |
| 02/14/08 11:06:54 | 46.73 | 13.51 | 202.91 |
| 02/14/08 11:07:04 | 47.01 | 13.31 | 212.40 |
| 02/14/08 11:07:14 | 47.37 | 14.08 | 212.11 |
| 02/14/08 11:07:24 | 46.44 | 14.22 | 183.06 |
| 02/14/08 11:07:34 | 45.83 | 13.90 | 191.14 |
| 02/14/08 11:07:44 | 45.00 | 14.02 | 198.35 |
| 02/14/08 11:07:54 | 44.09 | 13.74 | 202.28 |
| 02/14/08 11:08:04 | 44.38 | 13.75 | 193.80 |
| 02/14/08 11:08:14 | 44.71 | 13.83 | 176.34 |
| 02/14/08 11:08:24 | 45.32 | 14.27 | 152.89 |
| 02/14/08 11:08:34 | 45.82 | 14.31 | 143.96 |
| 02/14/08 11:08:44 | 44.36 | 13.30 | 150.47 |
| 02/14/08 11:08:54 | 0.00 | 0.00 | 0.00 |
| 02/14/08 11:09:04 | 45.53 | 13.73 | 171.04 |
| 02/14/08 11:09:14 | 48.24 | 13.37 | 198.03 |
| 02/14/08 11:09:24 | 47.60 | 13.72 | 202.00 |
| 02/14/08 11:09:34 | 46.72 | 14.10 | 185.78 |
| 02/14/08 11:09:44 | 45.56 | 13.87 | 187.01 |
| 02/14/08 11:09:54 | 44.37 | 14.16 | 178.63 |
| 02/14/08 11:10:04 | 44.42 | 13.82 | 171.51 |
| 02/14/08 11:10:14 | 44.36 | 14.07 | 168.29 |
| 02/14/08 11:10:24 | 44.97 | 13.87 | 169.53 |
| 02/14/08 11:10:34 | 45.49 | 14.26 | 174.75 |
| 02/14/08 11:10:44 | 45.58 | 14.36 | 191.43 |
| 02/14/08 11:10:54 | 45.56 | 14.89 | 201.96 |
| 02/14/08 11:11:04 | 42.88 | 14.39 | 224.40 |
| 02/14/08 11:11:14 | 40.45 | 14.03 | 227.70 |

| | | | |
|-------------------|-------|-------|--------|
| 02/14/08 11:11:24 | 40.85 | 14.08 | 217.23 |
| 02/14/08 11:11:34 | 41.08 | 13.78 | 194.14 |
| 02/14/08 11:11:44 | 42.59 | 13.20 | 186.69 |
| 02/14/08 11:11:54 | 43.78 | 13.55 | 198.33 |
| 02/14/08 11:12:04 | 45.27 | 13.28 | 203.52 |
| 02/14/08 11:12:14 | 47.03 | 12.94 | 198.96 |
| 02/14/08 11:12:24 | 48.24 | 12.86 | 184.03 |
| 02/14/08 11:12:34 | 49.72 | 12.66 | 188.78 |
| 02/14/08 11:12:44 | 50.02 | 12.42 | 195.67 |
| 02/14/08 11:12:54 | 50.60 | 12.55 | 188.23 |
| 02/14/08 11:13:04 | 51.17 | 12.52 | 181.11 |
| 02/14/08 11:13:14 | 51.78 | 12.61 | 174.43 |
| 02/14/08 11:13:24 | 52.70 | 12.86 | 172.39 |
| 02/14/08 11:13:34 | 53.63 | 13.16 | 197.14 |
| 02/14/08 11:13:44 | 51.50 | 12.97 | 225.89 |
| 02/14/08 11:13:54 | 49.36 | 13.29 | 257.59 |
| 02/14/08 11:14:04 | 48.21 | 13.47 | 254.84 |
| 02/14/08 11:14:14 | 47.08 | 12.79 | 228.01 |
| 02/14/08 11:14:24 | 47.03 | 12.31 | 202.56 |
| 02/14/08 11:14:34 | 46.71 | 12.28 | 187.58 |
| 02/14/08 11:14:44 | 49.69 | 12.48 | 174.80 |
| 02/14/08 11:14:54 | 52.70 | 12.23 | 166.82 |
| 02/14/08 11:15:04 | 53.06 | 12.24 | 171.29 |
| 02/14/08 11:15:14 | 53.01 | 11.84 | 197.08 |
| 02/14/08 11:15:24 | 54.79 | 12.13 | 225.57 |
| 02/14/08 11:15:34 | 56.25 | 11.75 | 254.84 |
| 02/14/08 11:15:44 | 55.06 | 12.22 | 280.37 |
| 02/14/08 11:15:54 | 53.57 | 12.41 | 268.12 |
| 02/14/08 11:16:04 | 53.59 | 13.00 | 236.04 |
| 02/14/08 11:16:14 | 53.32 | 12.72 | 203.48 |
| 02/14/08 11:16:24 | 51.79 | 12.93 | 191.43 |
| 02/14/08 11:16:34 | 50.29 | 13.00 | 189.95 |
| 02/14/08 11:16:44 | 49.73 | 13.13 | 190.86 |
| 02/14/08 11:16:54 | 49.12 | 13.55 | 200.25 |
| 02/14/08 11:17:04 | 48.15 | 13.70 | 213.63 |
| 02/14/08 11:17:14 | 47.30 | 13.18 | 219.32 |
| 02/14/08 11:17:24 | 46.11 | 12.89 | 209.47 |
| 02/14/08 11:17:34 | 45.29 | 12.93 | 191.77 |
| 02/14/08 11:17:44 | 47.02 | 13.04 | 188.47 |
| 02/14/08 11:17:54 | 49.13 | 12.37 | 206.74 |
| 02/14/08 11:18:04 | 49.75 | 12.16 | 212.14 |
| 02/14/08 11:18:14 | 50.28 | 12.36 | 201.97 |
| 02/14/08 11:18:24 | 51.50 | 11.78 | 170.43 |
| 02/14/08 11:18:34 | 52.73 | 11.83 | 151.36 |
| 02/14/08 11:18:44 | 55.61 | 12.03 | 166.78 |
| 02/14/08 11:18:54 | 58.35 | 11.52 | 193.86 |
| 02/14/08 11:19:04 | 57.47 | 11.10 | 210.28 |
| 02/14/08 11:19:14 | 56.52 | 11.58 | 187.60 |
| 02/14/08 11:19:24 | 58.34 | 11.81 | 169.79 |
| 02/14/08 11:19:34 | 59.92 | 12.15 | 170.69 |
| 02/14/08 11:19:44 | 57.11 | 12.14 | 183.18 |
| 02/14/08 11:19:54 | 54.54 | 12.84 | 192.64 |
| 02/14/08 11:20:04 | 53.62 | 13.16 | 192.33 |
| 02/14/08 11:20:14 | 52.75 | 13.70 | 188.80 |
| 02/14/08 11:20:24 | 49.98 | 13.77 | 173.31 |
| 02/14/08 11:20:34 | 47.07 | 13.43 | 165.64 |
| 02/14/08 11:20:44 | 46.19 | 13.20 | 178.08 |
| 02/14/08 11:20:54 | 45.32 | 12.28 | 198.00 |

| | | | |
|-------------------|-------|-------|--------|
| 02/14/08 11:21:04 | 46.74 | 12.54 | 237.84 |
| 02/14/08 11:21:14 | 48.23 | 12.23 | 245.04 |
| 02/14/08 11:21:24 | 48.82 | 11.91 | 252.42 |
| 02/14/08 11:21:34 | 49.11 | 12.72 | 264.79 |
| 02/14/08 11:21:44 | 50.87 | 13.13 | 246.64 |
| 02/14/08 11:21:54 | 52.71 | 13.08 | 236.36 |
| 02/14/08 11:22:04 | 50.30 | 13.49 | 215.09 |
| 02/14/08 11:22:14 | 47.97 | 14.05 | 194.73 |
| 02/14/08 11:22:24 | 46.43 | 14.08 | 192.97 |
| 02/14/08 11:22:34 | 44.67 | 14.92 | 195.63 |
| 02/14/08 11:22:44 | 43.24 | 14.55 | 183.98 |
| 02/14/08 11:22:54 | 41.69 | 14.47 | 172.70 |
| 02/14/08 11:23:04 | 41.15 | 14.60 | 168.63 |
| 02/14/08 11:23:14 | 40.45 | 15.04 | 155.92 |
| 02/14/08 11:23:24 | 39.62 | 15.04 | 136.14 |
| 02/14/08 11:23:34 | 38.70 | 14.79 | 150.48 |
| 02/14/08 11:23:44 | 38.73 | 14.65 | 164.17 |
| 02/14/08 11:23:54 | 39.03 | 14.00 | 190.52 |
| 02/14/08 11:24:04 | 39.91 | 13.85 | 206.19 |
| 02/14/08 11:24:14 | 40.86 | 14.15 | 199.84 |
| 02/14/08 11:24:24 | 41.51 | 13.90 | 180.70 |
| 02/14/08 11:24:34 | 42.26 | 13.88 | 168.62 |
| 02/14/08 11:24:44 | 42.59 | 14.26 | 165.62 |
| 02/14/08 11:24:54 | 43.22 | 13.82 | 168.88 |
| 02/14/08 11:25:04 | 42.30 | 14.01 | 178.39 |
| 02/14/08 11:25:14 | 41.75 | 13.78 | 182.28 |
| 02/14/08 11:25:24 | 42.36 | 13.88 | 184.63 |
| 02/14/08 11:25:34 | 42.63 | 13.93 | 197.74 |
| 02/14/08 11:25:44 | 42.92 | 14.48 | 199.77 |
| 02/14/08 11:25:54 | 42.93 | 14.22 | 198.36 |
| 02/14/08 11:26:04 | 41.67 | 13.75 | 195.34 |
| 02/14/08 11:26:14 | 40.51 | 13.23 | 225.04 |
| 02/14/08 11:26:24 | 42.89 | 13.09 | 228.92 |
| 02/14/08 11:26:34 | 44.98 | 12.93 | 235.14 |
| 02/14/08 11:26:44 | 45.87 | 13.29 | 231.55 |
| 02/14/08 11:26:54 | 46.76 | 13.66 | 233.68 |
| 02/14/08 11:27:04 | 45.58 | 14.38 | 254.85 |
| 02/14/08 11:27:14 | 44.12 | 13.98 | 262.13 |
| 02/14/08 11:27:24 | 42.63 | 13.77 | 243.57 |
| 02/14/08 11:27:34 | 41.13 | 13.54 | 205.56 |
| 02/14/08 11:27:44 | 42.04 | 13.65 | 179.52 |
| 02/14/08 11:27:54 | 43.21 | 13.79 | 167.95 |
| 02/14/08 11:28:04 | 43.49 | 14.08 | 171.51 |
| 02/14/08 11:28:14 | 43.81 | 14.13 | 168.61 |
| 02/14/08 11:28:24 | 42.33 | 13.67 | 179.85 |
| 02/14/08 11:28:34 | 40.86 | 13.77 | 196.50 |
| 02/14/08 11:28:44 | 42.00 | 13.40 | 232.15 |
| 02/14/08 11:28:54 | 43.23 | 13.48 | 238.66 |
| 02/14/08 11:29:04 | 43.51 | 12.83 | 218.66 |
| 02/14/08 11:29:14 | 44.05 | 12.37 | 213.01 |
| 02/14/08 11:29:24 | 45.86 | 12.36 | 204.38 |
| 02/14/08 11:29:34 | 47.90 | 11.81 | 209.45 |
| 02/14/08 11:29:44 | 49.76 | 12.33 | 232.10 |
| 02/14/08 11:29:54 | 51.73 | 12.53 | 231.80 |
| 02/14/08 11:30:04 | 50.62 | 12.36 | 204.95 |
| 02/14/08 11:30:14 | 49.39 | 12.41 | 183.14 |
| 02/14/08 11:30:24 | 49.69 | 12.79 | 159.88 |
| 02/14/08 11:30:34 | 50.01 | 12.63 | 167.12 |

| | | | |
|-------------------|-------|-------|--------|
| 02/14/08 11:30:44 | 48.83 | 12.91 | 182.85 |
| 02/14/08 11:30:54 | 47.87 | 13.09 | 178.64 |
| 02/14/08 11:31:04 | 47.93 | 12.81 | 170.99 |
| 02/14/08 11:31:14 | 47.93 | 13.54 | 187.91 |
| 02/14/08 11:31:24 | 46.49 | 13.62 | 207.89 |
| 02/14/08 11:31:34 | 45.00 | 13.49 | 217.25 |
| 02/14/08 11:31:44 | 43.53 | 13.28 | 209.72 |
| 02/14/08 11:31:54 | 42.03 | 12.62 | 218.13 |
| 02/14/08 11:32:04 | 43.79 | 12.46 | 209.12 |
| 02/14/08 11:32:14 | 45.33 | 12.25 | 207.05 |
| 02/14/08 11:32:24 | 47.33 | 12.27 | 200.54 |
| 02/14/08 11:32:34 | 49.40 | 12.75 | 197.40 |
| 02/14/08 11:32:44 | 48.23 | 13.52 | 204.41 |
| 02/14/08 11:32:54 | 47.06 | 13.77 | 197.79 |
| 02/14/08 11:33:04 | 44.98 | 13.42 | 198.96 |
| 02/14/08 11:33:14 | 42.91 | 13.07 | 202.32 |
| 02/14/08 11:33:24 | 43.52 | 13.85 | 185.20 |
| 02/14/08 11:33:34 | 44.09 | 13.57 | 232.20 |
| 02/14/08 11:33:44 | 42.33 | 13.89 | 282.78 |
| 02/14/08 11:33:54 | 40.51 | 13.49 | 260.65 |
| 02/14/08 11:34:04 | 41.76 | 13.37 | 217.84 |
| 02/14/08 11:34:14 | 42.90 | 13.72 | 190.60 |
| 02/14/08 11:34:34 | 43.22 | 13.03 | 191.75 |
| 02/14/08 11:34:44 | 45.29 | 13.10 | 194.14 |
| 02/14/08 11:34:54 | 47.04 | 13.47 | 208.85 |
| 02/14/08 11:35:04 | 45.31 | 13.96 | 241.23 |
| 02/14/08 11:35:14 | 43.85 | 14.30 | 255.71 |
| 02/14/08 11:35:24 | 42.03 | 14.18 | 239.20 |
| AVERAGE > | 46.04 | 13.33 | 195.53 |

APPENDIX C:
HIGH-FIRE PM TEST DATA

Bison Engineering
Method 201A Spreadsheet
Method 201A PM₁₀ & CT40 PM_{2.5} Test

| | |
|----------|-------------------|
| COMPANY | Bitter Root |
| FACILITY | Darby School |
| LOCATION | Darby, MT |
| SOURCE | Boiler, High Fire |
| DATE | Feb 14, 08 |

Method 201A PM10 & CT Method 40 PM2.5

| Client | Bitter Root | | | Number of Runs |
|---|-------------------|------------|------------|----------------|
| Facility | Darby School | | | 3 |
| Location | Darby, MT | | | |
| Source | Boiler, High Fire | | | |
| Test date | Feb 14, 08 | Feb 14, 08 | Feb 14, 08 | |
| Start time | 8:41 | 9:41 | 11:02 | |
| Test run | Three | Four | Five | |
| Preliminary info | | | | |
| Barometric pressure [Bp] | "Hg | 26.67 | 26.67 | 25.87 |
| Stack Diameter | inch | 20 | 20 | 20 |
| stack exit area | sqft | 2.18 | 2.18 | 2.18 |
| Meter box ID | | 2 | 2 | 2 |
| meter box Yi | | 1.003 | 1.003 | 1.003 |
| meter box delta H@ | | 1.76 | 1.76 | 1.76 |
| Pitot tube coefficient Cp | | 0.84 | 0.84 | 0.84 |
| Test Information | | | | |
| nozzle size [nz] | inch | 0.35 | 0.35 | 0.35 |
| filter number | | 2970 | 2971 | 2972 |
| Sample points | | 12 | 12 | 12 |
| Test duration | min | 48 | 48 | 48 |
| Isokinetics [i] | % | 95 | 120 | 122 |
| D50 cut rate | | 10.13 | 10.11 | 10.08 |
| Sample volume, eq 4.3 | dscf | 13.06 | 15.90 | 17.79 |
| avg delta P | "H2O | 0.042 | 0.041 | 0.038 |
| avg sqrt delta P | "H2O | 0.203 | 0.201 | 0.195 |
| 201A Constant sample rate delta H | "H2O | 0.45 | 0.60 | 0.60 |
| CT40 Constant sample rate delta H | "H2O | 0.41 | 0.54 | 0.55 |
| avg meter temp [Tm] | deg F | 78.6 | 76.3 | 77.9 |
| Stack Information | | | | |
| avg stack temp [Ts] | deg F | 343 | 329 | 332 |
| avg ABS stack temp [Ts] | deg R | 803 | 789 | 792 |
| actual stack flow | acf m | 1972 | 1971 | 1943 |
| actual stack velocity [Vs] | ft/sec | 15.1 | 15.1 | 14.8 |
| Standard stack flow | dscfm | 996 | 914 | 880 |
| Standard stack flow | dscf/hr | 59766 | 54818 | 52820 |
| stack moisture [bws], eq 4.4 | % v/v | 13.86 | 22.33 | 21.41 |
| measured static pressure | "H2O | 0 | 0 | 0 |
| stack static pressure [ps] | "Hg | 26.67 | 26.67 | 25.87 |
| Oxygen content | % O2 | 11.75 | 11.7 | 13.3 |
| Carbon dioxide content | % CO2 | 9.25 | 9.3 | 7.7 |
| Wet (Actual) Molecular Weight, Ms | lb/lb.mole | 28.3 | 27.3 | 27.2 |
| Dry Molecular Weight, Md | lb/lb.mole | 30.0 | 30.0 | 29.8 |
| AVERAGES | | | | |
| Lab Information | | | | |
| Impinger H2O Gain | mls | 35 | 85 | 91 |
| Impinger H2O volume [Vwc(STD)], eq 4.1 | scf | 1.65 | 4.00 | 4.28 |
| Silica Gel H2O Gain | grams (g) | 9.63 | 12.09 | 11.98 |
| Silica Gel volume [Vsg(STD)], eq 4.2 | scf | 0.45 | 0.57 | 0.56 |
| Lab Data, cyclone > than PM10 weight gain | grams (g) | NA | NA | NA |
| Lab Data, cyclone > PM2.5 weight gain | g | 0.0242 | 0.0264 | 0.0248 |
| Lab Data, cyclone PM2.5 weight gain | g | 0.0015 | 0.0040 | 0.0011 |
| Lab Data, Filter PM2.5 weight gain | g | 0.0197 | 0.0226 | 0.0221 |
| Lab data condensable PM (CPM) | g | 0.0005 | 0.0034 | 0.0034 |
| Lab data MeCl Matter (MCEM) | g | 0.0020 | 0.0020 | 0.0018 |
| cyclone > PM2.5 weight gain | grains (gr) | 0.3735 | 0.4074 | 0.3827 |
| cyclone PM2.5 weight gain | gr | 0.0231 | 0.0617 | 0.0170 |
| Filter PM2.5 weight gain | gr | 0.3040 | 0.3488 | 0.3411 |
| condensable PM (CPM) | gr | 0.0077 | 0.0525 | 0.0525 |
| MeCl Matter (MCEM) | gr | 0.0309 | 0.0309 | 0.0278 |
| AVERAGES | | | | |
| Grain loading Emissions | | | | |
| > PM2.5 cut | gr/dscf | 0.0286 | 0.0256 | 0.0215 |
| PM 2.5 cyclone & filter | gr/dscf | 0.0251 | 0.0258 | 0.0201 |
| condensable PM (CPM) | gr/dscf | 0.0006 | 0.0033 | 0.0029 |
| MeCl Matter (MCEM-CPM)) | gr/dscf | 0.0024 | 0.0019 | 0.0016 |
| EPA PM2.5 + CPM | gr/dscf | 0.0280 | 0.0311 | 0.0246 |
| Total PM | gr/dscf | 0.0566 | 0.0567 | 0.0461 |
| AVERAGES | | | | |
| Mass Rate Emissions | | | | |
| > PM2.5 cut | lbs/hr | 0.244 | 0.201 | 0.162 |
| PM 2.5 cyclone & filter | lbs/hr | 0.214 | 0.202 | 0.152 |
| condensable PM (CPM) | lbs/hr | 0.005 | 0.026 | 0.022 |
| MeCl Matter (MCEM-CPM)) | lbs/hr | 0.020 | 0.015 | 0.012 |
| EPA PM2.5 + CPM | lbs/hr | 0.239 | 0.243 | 0.186 |
| Total PM | lbs/hr | 0.483 | 0.444 | 0.348 |
| AVERAGES | | | | |
| Emission Factor | | | | |
| lab analysis Fd @ 0% oxygen | dscf/MMBtu @ 0% | 9399 | 9399 | 9399 |
| lab analysis Fd @ stack conditions | dscf/MMBtu @ SK | 21469 | 21352 | 25847 |
| EPA PM2.5 + CPM | lbs/MMBtu | 0.086 | 0.095 | 0.091 |
| TPM | lbs/MMBtu | 0.174 | 0.173 | 0.170 |
| Boiler operating rate | MMBtu/hr | 2.78 | 2.57 | 2.04 |
| | | | | 2.4649 |

Test Run 3 Bison Engineering, Method 201A FM10 & CT40 PM_{2.5} Spreadsheet

Date by iw Checked by CWL

| Facility: | Bitter Root | Location: | Darby, MT | Date: | Feb 14, 08 |
|------------------------|--|--------------------------|-------------------|---|------------------------------|
| Operators: | Filter # | Source: | Boiler, High Fire | Start time: | 8:41 |
| PRELIMINARY INFO. | | | | | |
| P _m | Bp | 26.67 ("Hg) | Rect. sqft | 234.74 (micropoise) | |
| Diam | 20 (inches) | 2.18 | Rnd sqft | 0.671 (ft ³ /min) | |
| Stack AREA | | 2.18 | 0 (sqft) | 0.45 ("H ₂ O) | |
| Meter Box | Y _f | 1.003 | | RANGE 0.40 - 50 °F | 0.52 + 50 °F |
| 2 | Delta H @ | 1.76 | | | |
| PRE TEST INFO | | | | | |
| Assumed moisture | | 12.0 (%) | (% deg F) | us CT40 stack viscosity | 228.19 (micropoise) |
| Assumed Meter Temp | | 60.0 | (deg F) | us 201A stack viscosity | 234.74 (micropoise) |
| Target Run Time | | 48.0 (min) | | Qs 201A Cylone flow rate | 0.671 (ft ³ /min) |
| Total Number of Points | | 12 | | ΔH 201A Delta H ==> | 0.45 ("H ₂ O) |
| TRAVEVERSE INFO | | | | | |
| P _g | Static gage pressure | 0.00 ("H ₂ O) | | Ps Stack pressure, P _s | 26.67 ("Hg) |
| Stack Temp, Ts | | 320.0 (deg F) | | Bws % H ₂ O in Stack | 13.86 (Bws) |
| O ₂ | Abs stack Temp, Ts | 780 (deg R) | | Mw Actual Wet Molecular Weight | 28.29 (lb/lb.mole) |
| O ₂ | Oxygen, dry | 11.8 (% v/v d) | | Vs Dry STD sample Volume | 13.06 (dsfc) |
| O ₂ | Oxygen, wet | 10.34 (% v/v w) | | Final Sampling Time | 45.0 (min) |
| CO ₂ | Carbon Dioxide, dry | 9.3 (% v/v d) | | us Post test stack viscosity | 239.59 (micropoise) |
| CO ₂ | Carbon Dioxide, wet | 29.95 (lb/lb.mole) | | C Post test Cunningham corr. factor | 1.12 |
| CO ₂ | Molecular weight, dry | 28.516 (lb/lb.mole) | | D _{50L} Post test lower limit cut diameter | 9.26 (micrometers) |
| NOZZLE SELECTION | | | | | |
| CT40 | N1-125 N2-138 N3-156 N4-172 N5-188 N6-20 N7-22 N8-25 | | | D _{50T} Post test cut diam for cyclone | 10.13 (micrometers) |
| | | | | Q _{s std} Post test cyclone flow rate | 0.68 (ft ³ /min) |
| | | | | I Isokinetic Avg. { 60 < l < 120 } | 95 (%) |
| | | | | D50 D50 Cut Rate, { 9 < d50 < 11 } | 10.1 (μm) |
| POST TEST INFO | | | | | |
| | | | | S T A C K | |
| | | | | Flow acfm | Flow dscfm |
| | | | | Vel. ft/sec | |
| | | | | Assumed % l | % l |
| | | | | Actual % l | Rolling % l |
| | | | | 14.87 | 1947 |
| | | | | 100 | 975 |
| | | | | | |
| Test No | Pre traverse dP | Point sqrt dP | Run Time | MetrVol | Vel head |
| 1 | 0.040 | 0.20 | 3.7 | 842.00 | delta P sqrt dP |
| 2 | 0.050 | 0.22 | 4.1 | 843.260 | delta H |
| 3 | 0.060 | 0.24 | 4.1 | 844.500 | 0.20 |
| 4 | 0.050 | 0.22 | 3.7 | 845.760 | 0.45 |
| 5 | 0.040 | 0.20 | 3.7 | 846.880 | 0.22 |
| 6 | 0.040 | 0.20 | 3.7 | 848.020 | 0.20 |
| 7 | 0.040 | 0.20 | 3.2 | 849.060 | 0.45 |
| 8 | 0.050 | 0.22 | 3.7 | 850.100 | 0.17 |
| 9 | 0.060 | 0.24 | 4.1 | 851.410 | 0.20 |
| 10 | 0.050 | 0.22 | 4.1 | 852.920 | 0.050 |
| 11 | 0.040 | 0.20 | 3.7 | 854.410 | 0.050 |
| 12 | 0.040 | 0.20 | 3.2 | 855.760 | 0.040 |
| | avg. dP | | sample volume | 14.879 | avg. dP |
| | 0.047 | 0.215 | | 0.042 | 0.203 |
| | avg. sqrt dP squared | 0.046 | | 0.45 | 342.50 |
| | | | | | T _s |
| | | | | | T _m °R |
| | | | | | 78.63 |
| | | | | | 802.50 |
| | | | | | 538.63 |
| | | | | | 15.07 |
| | | | | | 1972 |
| | | | | | 996 |

Revised Sept 08/01 by CWL

Test Run 4 Bison Engineering, Method 201A PM₁₀ & CT40 PM_{2.5} Spreadsheet

| Facility: Operators: | Bitter Root Filter # | Location: Source: | Dauby, MT Boiler, High Fire | Date: Start time: 9:41 | Feb 14, 08 End time: | Data by iw | Checked by cwl |
|---|---|--|--|--|--|--|--|
| PRELIMINARY INFO. | | | | | | | |
| Pm Bp Diam Lngth Wdth (inches) Stack AREA Meter Box 2 Yi 2 Delta H @ | | | | | | | |
| 26.67 ("Hg) 0 2.18 0 2.18 (sqft) 1.003 1.76 | | | | | | | |
| PRE TEST INFO | | | | | | | |
| Pg Static, gage pressure Stack Temp, Ts O ₂ Abs stack Temp, Ts CO ₂ Oxygen, dry Carbon Dioxide, dry Molecular weight, dry Molecular weight, wet | 0.00 ("H ₂ O) 380.0 (deg F) 840 (deg R) 11.7 (% v/v d) 11.349 (% v/v w) 9.3 (% v/v d) 29.956 (lb/lb.mole) 29.59732 (lb/lb.mole) | ("H ₂ O) (deg F) (deg R) (% v/v d) (% v/v w) (% v/v d) (lb/lb.mole) (lb/lb.mole) | Rect. sqft 0 2.18 0 1.003 1.76 | 0 2.18 (sqft) 1.003 1.76 | 3.0 (%) 75.0 (deg F) 48.0 (min) 12 | 3.0 (%) 75.0 (deg F) 48.0 (min) 12 | |
| TRAVERSE INFO | | | | | | | |
| Pg Static, gage pressure Stack Temp, Ts O ₂ Abs stack Temp, Ts CO ₂ Oxygen, dry Carbon Dioxide, dry Molecular weight, dry Molecular weight, wet | 0.00 ("H ₂ O) 380.0 (deg F) 840 (deg R) 11.7 (% v/v d) 11.349 (% v/v w) 9.3 (% v/v d) 29.956 (lb/lb.mole) 29.59732 (lb/lb.mole) | ("H ₂ O) (deg F) (deg R) 11.7 (% v/v d) 11.349 (% v/v w) 9.3 (% v/v d) 29.956 (lb/lb.mole) 29.59732 (lb/lb.mole) | Rect. sqft 0 2.18 0 1.003 1.76 | 0 2.18 (sqft) 1.003 1.76 | 3.0 (%) 75.0 (deg F) 48.0 (min) 12 | 3.0 (%) 75.0 (deg F) 48.0 (min) 12 | |
| POST TEST INFO | | | | | | | |
| Impinger water CALCULATED RESULTS | | | | | | | |
| P _s Stack pressure, Ps Bws % H ₂ O in Stack Mw Actual Wet Molecular Weight Vs Dry STD sample Volume Final Sampling Time | 0.746 ("Hg) 0.60 ("H ₂ O) 0.68 + 50 °F 249.60 (micropoise) 1.13 | 0.746 ("Hg) 0.60 ("H ₂ O) 0.68 + 50 °F 249.60 (micropoise) 1.13 | 0.746 ("Hg) 0.60 ("H ₂ O) 0.68 + 50 °F 249.60 (micropoise) 1.13 | 0.746 ("Hg) 0.60 ("H ₂ O) 0.68 + 50 °F 249.60 (micropoise) 1.13 | 0.746 ("Hg) 0.60 ("H ₂ O) 0.68 + 50 °F 249.60 (micropoise) 1.13 | 0.746 ("Hg) 0.60 ("H ₂ O) 0.68 + 50 °F 249.60 (micropoise) 1.13 | 0.746 ("Hg) 0.60 ("H ₂ O) 0.68 + 50 °F 249.60 (micropoise) 1.13 |
| D _{cycl} Lower limit cut diameter D _{50t} Cut diam for cyclone Qs CT40 Cyclone flow rate Nre Reynolds number | 9.27 (micrometers) 10.14 (micrometers) 0.708 (ft ³ /min) 2302 Nre < 3162 * | 9.27 (micrometers) 10.14 (micrometers) 0.708 (ft ³ /min) 2302 Nre < 3162 * | 9.27 (micrometers) 10.14 (micrometers) 0.708 (ft ³ /min) 2302 Nre < 3162 * | 9.27 (micrometers) 10.14 (micrometers) 0.708 (ft ³ /min) 2302 Nre < 3162 * | 9.27 (micrometers) 10.14 (micrometers) 0.708 (ft ³ /min) 2302 Nre < 3162 * | 9.27 (micrometers) 10.14 (micrometers) 0.708 (ft ³ /min) 2302 Nre < 3162 * | 9.27 (micrometers) 10.14 (micrometers) 0.708 (ft ³ /min) 2302 Nre < 3162 * |
| ΔH CT40 Delta H ==> Range | 0.48 - 50 °F 0.62 + 50 °F | 0.48 - 50 °F 0.62 + 50 °F | 0.48 - 50 °F 0.62 + 50 °F | 0.48 - 50 °F 0.62 + 50 °F | 0.48 - 50 °F 0.62 + 50 °F | 0.48 - 50 °F 0.62 + 50 °F | 0.48 - 50 °F 0.62 + 50 °F |
| NOZZLE SELECTION | | | | | | | |
| 201A • 136 • 15 • 164 • 182 • 197 • 215 • 233 • 264 • 3 • 342 • 39 CT40 N1-125 N2-138 N3-156 N4-172 N5-188 N6-20 N7-22 N8-25 | | | | | | | |
| H ₂ O Nozzle Diameter estimate H ₂ O Delta P (min) H ₂ O Delta P (max) H ₂ O Alt - delta P (min) H ₂ O Alt - delta P (max) | 0.379 Selected > 0.35 ERR NA ERR ERR 0.142 | 0.379 Selected > 0.35 ERR NA ERR ERR 0.128 | 0.379 Selected > 0.35 ERR NA ERR ERR 0.142 |
| S T A C K | | | | | | | |
| Test Pre traverse No dP sqrt dP | Point Time 3.9 | Run Time 3.9 | MetrVol 857.00 | Vel head delta P sqrt dP 0.040 0.20 | 201A CT40 Stack Meter Temp delta H 0.60 0.20 | Assumed % I 65.01 77 | Rolling % I 81 81 |
| 1 0.040 0.20 | 3.9 | 3.9 | 858.000 | 0.040 0.20 | 326 77 | 65.01 77 | 14.93 14.93 |
| 2 0.050 0.22 | 3.9 | 7.8 | 859.110 | 0.040 0.20 | 322 76 | 72.11 76 | 14.89 14.89 |
| 3 0.050 0.22 | 4.4 | 12.2 | 861.120 | 0.050 0.22 | 324 76 | 103.66 76 | 16.67 16.67 |
| 4 0.040 0.20 | 4.4 | 16.6 | 863.550 | 0.050 0.22 | 338 76 | 75.5 75 | 15.8 15.8 |
| 5 0.040 0.20 | 3.9 | 20.5 | 865.020 | 0.040 0.20 | 320 76 | 95.96 76 | 12.0 12.0 |
| 6 0.040 0.20 | 3.9 | 24.4 | 866.480 | 0.040 0.20 | 332 77 | 95.37 76 | 11.9 11.9 |
| 7 0.030 0.17 | 3.9 | 28.3 | 867.930 | 0.040 0.20 | 341 78 | 95.16 77 | 11.7 11.7 |
| 8 0.040 0.20 | 4.4 | 32.7 | 869.640 | 0.050 0.22 | 334 78 | 88.58 77 | 11.6 11.6 |
| 9 0.050 0.22 | 3.9 | 36.6 | 871.050 | 0.040 0.20 | 326 77 | 91.75 76 | 11.5 11.5 |
| 10 0.050 0.22 | 3.9 | 40.5 | 872.510 | 0.040 0.20 | 315 77 | 94.43 76 | 11.6 11.6 |
| 11 0.040 0.20 | 3.4 | 43.9 | 873.800 | 0.030 0.17 | 330 77 | 111.57 76 | 11.8 11.8 |
| 12 0.030 0.17 | 3.4 | 47.3 | 875.040 | 0.030 0.17 | 326 77 | 106.98 76 | 11.9 11.9 |
| avg dP avg dP sample volume | 18.040 | avg dP avg dP | 0.45 | dH Ts | Tm | Flow acfm | Flow acfm |
| 0.042 0.203 | 0.201 | 0.45 | 328.75 | Ts °F | 76.33 | 914 | 914 |
| avg sqrt dP squared | 0.041 | 0.201 | 0.45 | 788.75 | Ts °R | 536.33 | |

Revised Sept 08/01 by cwl

Test Run 5 Bison Engineering, Method 201A PM10 & CT40 PM_{2.5} Spreadsheet

Data by JW Checked by CW

Facility: Bitter Root Location: Darby, MT
Operators: Filter # 2972 Source: Boiler, High Fire

Date: Feb 14, 08
Start time: 11:02
End time:

| PRELIMINARY INFO. | | | | | | | | | | POST TEST INFO | | | | | | | | | | | |
|----------------------------|---------------------|--------------------------|---------------|-----------------------------------|----------------------|--|------------|--|--------|---|--------|---|--------|--|---------------|-------------------------------------|-----------|------------------------------------|-----------|-----|--|
| 201A Calculations | | | | | 201A Stack Viscosity | | | | | Impinger water | | | | | 91 Silica gel | | | | | | |
| (inches) | | Pm Bp | | 25.87 ("Hg) | | us 201A stack viscosity | | 258.91 (micropoise) | | Ps Stack pressure, Ps | | 25.87 ("Hg) | | Bws % H2O in Stack | | 21.41 (Bws) (lb/lb.mole) | | 27.24 (dscf) (min) | | | |
| Stack AREA | | Diam 20 | | Width 0 | | Qs 201A Cyclone flow rate | | 0.756 (ft ³ /min) | | Mw Actual Molar Weight | | 17.79 | | Vs Dry STD sample Volume | | 54.0 (micropoise) | | 231.83 (micropoise) | | | |
| Meter Box | | Yi 1.003 | | Rng soft 2.18 (sqft) | | ΔH 201A Delta H ==> | | 0.60 ("H20) | | Final Sampling Time | | us Post test stack viscosity | | 1.12 (C Post test Cunningham corr. factor) | | 9.16 (micrometers) | | 10.08 (micrometers) | | | |
| 2 | | Delta H @ 1.76 | | RANGE 0.54 - 50 °F | | 0.68 + 50 °F | | us CT40 stack viscosity | | 250.52 (micropoise) | | us Post test stack viscosity | | 0.57 (ft ³ /min) | | 122 (%) | | 10.1 (um) | | | |
| PRE TEST INFO | | | | | | | | | | CALCULATED RESULTS | | | | | | | | | | | |
| Assumed moisture | | 3.0 (%) | | Assumed Meter Temp | | 78.0 (deg F) | | Target Run Time | | 48.0 (min) | | Nre Reynolds number | | 2252 Nre < 3162 * | | Ds01 Cut diam for cyclone | | 10.11 (micrometers) | | | |
| Total Number of Points | | 12 | | ΔH CT40 Delta H ==> | | 0.55 ("H20) | | Ds01 Lower limit cut diameter | | 9.22 (micrometers) | | Ds01 Post test lower limit cut diameter | | 0.721 (ft ³ /min) | | Ds01 Post test cut diam for cyclone | | 2.3183 (micropoise) | | | |
| Pg Static, gage pressure | | 0.00 ("H2O) | | Assumed Meter Temp | | 380.0 (deg F) | | Target Run Time | | 840 (deg R) | | Nre Reynolds number | | 2252 Nre < 3162 * | | Ds01 Post test cyclone flow rate | | 231.83 (micropoise) | | | |
| Stack Temp, Ts | | 12.3 (% v/v d) | | 12.901 (% v/v w) | | 12.7 (% v/v d) | | 29.764 (lb/lb.mole) | | 29.41108 (lb/lb.mole) | | ΔH CT40 Delta H ==> | | 0.49 - 50 °F | | 0.62 + 50 °F | | 1 Isokinetic Avg, { 80 < < 120 } | | | |
| TRAVERSE INFO | | | | | | | | | | NOZZLE SELECTION | | | | | | | | | | | |
| Pg | | Nozzle Diameter estimate | | 0.381 Selected > 0.35 | | 201A • 136 • 15 • 164 • 182 • 197 • 215 • 233 • 264 • 3 • 342 • 39 | | C T40 N1•125 N2•138 N3•156 N4•172 N5•188 N6•20 N7•22 N8•25 | | H ₂ O Nozzle Diameter estimate | | ERR | | ERR | | AVG | | ERR | | ERR | |
| Stack Temp, Ts | | 12.3 (% v/v d) | | 12.7 (% v/v w) | | 12.901 (% v/v d) | | 29.764 (lb/lb.mole) | | 29.41108 (lb/lb.mole) | | H ₂ O nozzle P (min) | | NA | | NA | | ERR | | ERR | |
| O ₂ Oxygen, dry | | Oxygen, wet | | O ₂ Abs stack Temp, Ts | | 12.3 (% v/v d) | | 12.7 (% v/v w) | | 12.901 (% v/v d) | | H ₂ O delta P (max) | | ERR | | ERR | | 0.128 | | ERR | |
| TEST INFO | | | | | | | | | | S T A C K | | | | | | | | | | | |
| Test No | Pre traverse dP | Point Time | Run Time | MetrVol | Vel head | 201A CT40 delta H | Stack Temp | Meter Temp | Vel. I | Assumed | Actual | Rolling | Vel. I | Flow acfm | Flow acfm | Flow acfm | Flow acfm | Flow acfm | Flow acfm | | |
| 1 | 0.040 | 0.20 | 4.0 | 876.00 | delta P | sqrt dP | 0.030 | 0.17 | 0.60 | 324 | 78 | 77 | 77.5 | 107.81 | 133 | 13.12 | 1717 | 786 | | | |
| 2 | 0.040 | 0.20 | 4.6 | 8.6 | 879.400 | 0.040 | 0.20 | 0.60 | 330 | 78 | 77 | 77.5 | 103.24 | 127 | 15.21 | 1990 | 904 | | | | |
| 3 | 0.050 | 0.22 | 4.6 | 13.2 | 881.180 | 0.040 | 0.20 | 0.60 | 336 | 78 | 77 | 77.5 | 97.08 | 120 | 15.26 | 1998 | 900 | | | | |
| 4 | 0.050 | 0.22 | 5.2 | 18.4 | 883.210 | 0.050 | 0.22 | 0.60 | 338 | 78 | 77 | 77.5 | 87.71 | 108 | 17.09 | 2237 | 1006 | | | | |
| 5 | 0.040 | 0.20 | 4.6 | 23.0 | 884.960 | 0.040 | 0.20 | 0.60 | 340 | 79 | 77 | 78.5 | 95.60 | 118 | 15.30 | 2003 | 898 | | | | |
| 6 | 0.040 | 0.20 | 4.6 | 27.6 | 886.690 | 0.040 | 0.20 | 0.60 | 335 | 79 | 77 | 78.5 | 94.21 | 116 | 12.22 | 1730 | 780 | | | | |
| 7 | 0.040 | 0.20 | 4.0 | 31.6 | 888.180 | 0.030 | 0.17 | 0.60 | 336 | 80 | 77 | 78.5 | 107.71 | 133 | 13.22 | 1730 | 780 | | | | |
| 8 | 0.050 | 0.22 | 4.6 | 36.2 | 889.970 | 0.040 | 0.20 | 0.60 | 336 | 80 | 77 | 78.5 | 97.45 | 120 | 15.26 | 1998 | 900 | | | | |
| 9 | 0.040 | 0.20 | 5.2 | 41.4 | 892.110 | 0.050 | 0.22 | 0.60 | 323 | 79 | 77 | 78 | 91.51 | 113 | 12.21 | 16.92 | 2215 | 1015 | | | |
| 10 | 0.040 | 0.20 | 4.6 | 46.0 | 893.770 | 0.040 | 0.20 | 0.60 | 323 | 79 | 77 | 78 | 89.71 | 111 | 12.0 | 15.14 | 1982 | 908 | | | |
| 11 | 0.030 | 0.17 | 4.0 | 50.0 | 895.120 | 0.030 | 0.17 | 0.60 | 329 | 79 | 77 | 78 | 97.25 | 120 | 13.16 | 1723 | 783 | | | | |
| 12 | 0.030 | 0.17 | 4.0 | 54.0 | 896.870 | 0.030 | 0.17 | 0.60 | 331 | 79 | 77 | 78 | 126.23 | 156 | 12.3 | 13.18 | 1725 | 782 | | | |
| | avg dP | avg. dP | sample volume | 20.870 | avg. dP | avg. dP | dH | T _s | | T _m | | | fl/sec | acfm | acfm | acfm | acfm | acfm | 880 | | |
| | 0.041 | 0.201 | | | 0.038 | 0.195 | 0.45 | 331.75 | is °F | 77.92 | °F | | | 14.84 | 1943 | | | | | | |
| | avg sqrt dP squared | 0.041 | | | | | | | | 791.75 | Ts °R | 537.92 | | | | | | | | | |

Revised Sept 08/01 by CWL

APPENDIX D:
HIGH-FIRE NO_x AND CO TEST DATA

Darby High NOx CO test data

| | | | Run 3 | Run 4 | Run 5 | Avg. |
|-----------------------------------|-----------|-----------|-----------|-----------|-----------|------|
| Stack Flow | dscfh | 59766 | 54818 | 52820 | 57292 | |
| Heat input | MMBtu/hr | 2.78 | 2.57 | 2.04 | 2.7 | |
| NOx source concentration | ppmvd | 54.0 | 54.1 | 46.0 | 51.4 | |
| NOx concentration, M19 conversion | lbs/dscf | 6.424E-06 | 6.440E-06 | 5.479E-06 | 6.114E-06 | |
| NOx mass rate | lbs/hr | 0.384 | 0.353 | 0.289 | 0.342 | |
| NOx emission factor | lbs/MMBtu | 0.138 | 0.138 | 0.142 | 0.139 | |
| CO source concentration | ppmvd | 176.7 | 183.6 | 195.5 | 185.3 | |
| CO concentration, M19 conversion | lbs/dscf | 1.284E-05 | 1.334E-05 | 1.421E-05 | 1.346E-05 | |
| CO mass rate | lbs/hr | 0.768 | 0.731 | 0.751 | 0.750 | |
| NOx emission factor | lbs/MMBtu | 0.276 | 0.285 | 0.367 | 0.309 | |

Darby Test, Run 1 High Fire

| Date/Time mm/dd/yy hh:mm:ss | NOx ppm | O2 % | CO ppm |
|--------------------------------|------------|---------|-----------|
| 02/13/08 16:30:36 | 57.67 | 9.26 | 199.16 |
| 02/13/08 16:30:46 | 58.28 | 9.83 | 204.87 |
| 02/13/08 16:30:56 | 58.84 | 10.52 | 189.93 |
| 02/13/08 16:31:06 | 57.66 | 10.67 | 178.82 |
| 02/13/08 16:31:16 | 56.48 | 10.95 | 170.37 |
| 02/13/08 16:31:26 | 54.17 | 10.61 | 158.23 |
| 02/13/08 16:31:36 | 51.74 | 10.15 | 148.65 |
| 02/13/08 16:31:46 | 52.74 | 10.20 | 145.38 |
| 02/13/08 16:31:56 | 53.32 | 10.23 | 152.54 |
| 02/13/08 16:32:06 | 53.90 | 10.12 | 157.66 |
| 02/13/08 16:32:16 | 54.48 | 10.10 | 160.41 |
| 02/13/08 16:32:26 | 54.83 | 10.52 | 154.30 |
| 02/13/08 16:32:36 | 54.93 | 10.46 | 156.48 |
| 02/13/08 16:32:46 | 54.13 | 9.97 | 155.85 |
| 02/13/08 16:32:56 | 53.00 | 10.17 | 164.11 |
| 02/13/08 16:33:06 | 54.20 | 10.30 | 165.55 |
| 02/13/08 16:33:16 | 55.29 | 9.82 | 165.62 |
| 02/13/08 16:33:26 | 54.47 | 10.03 | 162.07 |
| 02/13/08 16:33:36 | 53.91 | 10.66 | 152.55 |
| 02/13/08 16:33:46 | 53.91 | 10.63 | 144.79 |
| 02/13/08 16:33:56 | 53.61 | 10.34 | 143.91 |
| 02/13/08 16:34:06 | 52.69 | 10.23 | 161.58 |
| 02/13/08 16:34:16 | 51.76 | 10.15 | 162.36 |
| 02/13/08 16:34:26 | 52.98 | 10.11 | 181.55 |
| 02/13/08 16:34:36 | 53.84 | 11.09 | 186.08 |
| 02/13/08 16:34:46 | 53.28 | 11.25 | 167.91 |
| 02/13/08 16:34:56 | 52.38 | 11.34 | 146.59 |
| 02/13/08 16:35:06 | 49.72 | 10.38 | 133.42 |
| 02/13/08 16:35:16 | 47.30 | 9.99 | 134.67 |
| 02/13/08 16:35:26 | 50.58 | 10.20 | 148.35 |
| 02/13/08 16:35:36 | 53.86 | 9.97 | 158.86 |
| 02/13/08 16:35:46 | 54.46 | 10.12 | 163.26 |
| 02/13/08 16:35:56 | 54.75 | 10.50 | 176.88 |
| 02/13/08 16:36:06 | 53.58 | 10.30 | 318.47 |
| 02/13/08 16:36:16 | 52.38 | 10.26 | 363.38 |
| 02/13/08 16:36:26 | 53.27 | 10.55 | 322.41 |
| 02/13/08 16:36:36 | 54.15 | 10.48 | 236.25 |
| 02/13/08 16:36:46 | 52.06 | 9.90 | 191.94 |
| 02/13/08 16:36:56 | 50.30 | 9.67 | 184.80 |
| 02/13/08 16:37:06 | 52.40 | 9.69 | 200.12 |
| 02/13/08 16:37:16 | 54.78 | 10.38 | 208.73 |
| 02/13/08 16:37:26 | 54.77 | 9.67 | 187.22 |
| 02/13/08 16:37:36 | 54.79 | 9.04 | 175.86 |
| 02/13/08 16:37:46 | 55.62 | 9.80 | 194.93 |
| 02/13/08 16:37:56 | 56.47 | 10.39 | 193.79 |
| 02/13/08 16:38:06 | 55.86 | 10.72 | 177.49 |
| 02/13/08 16:38:16 | 55.33 | 10.73 | 156.18 |
| 02/13/08 16:38:26 | 52.98 | 10.60 | 147.13 |
| 02/13/08 16:38:36 | 50.60 | 11.21 | 151.03 |
| 02/13/08 16:38:46 | 50.55 | 10.99 | 150.71 |
| 02/13/08 16:38:56 | 50.59 | 11.07 | 149.24 |
| 02/13/08 16:39:06 | 50.03 | 11.48 | 146.25 |
| 02/13/08 16:39:16 | 49.66 | 11.35 | 140.23 |

| | | | |
|-------------------|-------|-------|--------|
| 02/13/08 16:39:26 | 48.22 | 10.83 | 130.07 |
| 02/13/08 16:39:36 | 47.01 | 10.13 | 129.57 |
| 02/13/08 16:39:46 | 49.11 | 10.18 | 129.57 |
| 02/13/08 16:39:56 | 51.49 | 10.48 | 136.41 |
| 02/13/08 16:40:06 | 52.67 | 10.74 | 145.11 |
| 02/13/08 16:40:16 | 53.58 | 10.33 | 154.96 |
| 02/13/08 16:40:26 | 52.71 | 10.47 | 168.79 |
| 02/13/08 16:40:36 | 51.44 | 10.42 | 162.36 |
| 02/13/08 16:40:46 | 52.00 | 10.26 | 157.37 |
| 02/13/08 16:40:56 | 52.36 | 10.20 | 149.57 |
| 02/13/08 16:41:06 | 53.59 | 10.42 | 146.59 |
| 02/13/08 16:41:16 | 54.52 | 10.68 | 149.80 |
| 02/13/08 16:41:26 | 53.61 | 10.26 | 147.77 |
| 02/13/08 16:41:36 | 52.68 | 10.37 | 150.11 |
| 02/13/08 16:41:46 | 52.95 | 10.73 | 151.03 |
| 02/13/08 16:41:56 | 53.31 | 10.89 | 155.54 |
| 02/13/08 16:42:06 | 52.36 | 10.96 | 160.35 |
| 02/13/08 16:42:16 | 51.45 | 10.96 | 148.95 |
| 02/13/08 16:42:26 | 50.94 | 11.06 | 133.77 |
| 02/13/08 16:42:36 | 49.99 | 10.45 | 128.30 |
| 02/13/08 16:42:46 | 50.26 | 10.41 | 134.66 |
| 02/13/08 16:42:56 | 50.27 | 9.81 | 137.03 |
| 02/13/08 16:43:06 | 52.41 | 9.85 | 141.51 |
| 02/13/08 16:43:16 | 54.51 | 9.97 | 138.77 |
| 02/13/08 16:43:26 | 55.27 | 10.25 | 135.85 |
| 02/13/08 16:43:36 | 55.89 | 10.63 | 139.68 |
| 02/13/08 16:43:46 | 55.27 | 10.56 | 145.11 |
| 02/13/08 16:43:56 | 54.78 | 10.66 | 147.43 |
| 02/13/08 16:44:06 | 53.56 | 10.66 | 139.34 |
| 02/13/08 16:44:16 | 52.06 | 10.72 | 138.38 |
| 02/13/08 16:44:26 | 51.75 | 11.12 | 141.17 |
| 02/13/08 16:44:36 | 51.20 | 11.08 | 137.60 |
| 02/13/08 16:44:46 | 50.30 | 11.03 | 134.30 |
| 02/13/08 16:44:56 | 49.12 | 11.44 | 133.76 |
| 02/13/08 16:45:06 | 49.39 | 10.74 | 138.43 |
| 02/13/08 16:45:16 | 49.37 | 10.64 | 152.88 |
| 02/13/08 16:45:26 | 50.32 | 10.46 | 160.36 |
| 02/13/08 16:45:36 | 51.19 | 10.31 | 155.26 |
| 02/13/08 16:45:46 | 52.95 | 10.55 | 155.28 |
| 02/13/08 16:45:56 | 55.00 | 10.41 | 150.49 |
| 02/13/08 16:46:06 | 53.66 | 10.65 | 144.81 |
| 02/13/08 16:46:16 | 51.77 | 10.79 | 138.15 |
| 02/13/08 16:46:26 | 51.45 | 10.87 | 137.01 |
| 02/13/08 16:46:36 | 51.15 | 10.64 | 133.18 |
| 02/13/08 16:46:46 | 51.47 | 10.84 | 134.04 |
| 02/13/08 16:46:56 | 51.48 | 10.45 | 138.70 |
| 02/13/08 16:47:06 | 50.83 | 10.32 | 145.94 |
| 02/13/08 16:47:16 | 50.26 | 10.79 | 153.43 |
| 02/13/08 16:47:26 | 51.13 | 10.81 | 165.59 |
| 02/13/08 16:47:36 | 52.09 | 10.12 | 163.23 |
| 02/13/08 16:47:46 | 51.43 | 9.98 | 152.16 |
| 02/13/08 16:47:56 | 50.84 | 10.02 | 141.18 |
| 02/13/08 16:48:06 | 53.01 | 10.41 | 139.04 |
| 02/13/08 16:48:16 | 54.79 | 10.56 | 137.34 |
| 02/13/08 16:48:26 | 53.56 | 10.93 | 138.43 |
| 02/13/08 16:48:36 | 52.06 | 10.18 | 146.25 |
| 02/13/08 16:48:46 | 51.74 | 10.43 | 158.25 |
| 02/13/08 16:48:56 | 51.19 | 10.86 | 153.45 |

| | | | |
|-------------------|-------|-------|--------|
| 02/13/08 16:49:06 | 51.79 | 9.96 | 147.45 |
| 02/13/08 16:49:16 | 52.05 | 9.95 | 162.64 |
| 02/13/08 16:49:26 | 54.14 | 10.19 | 161.28 |
| 02/13/08 16:49:36 | 55.92 | 9.71 | 152.56 |
| 02/13/08 16:49:46 | 54.77 | 9.57 | 156.47 |
| 02/13/08 16:49:56 | 53.87 | 10.00 | 161.25 |
| 02/13/08 16:50:06 | 55.01 | 10.80 | 165.89 |
| 02/13/08 16:50:16 | 56.22 | 10.58 | 174.18 |
| 02/13/08 16:50:26 | 53.59 | 10.39 | 166.77 |
| 02/13/08 16:50:36 | 51.13 | 10.38 | 156.47 |
| 02/13/08 16:50:46 | 51.48 | 10.68 | 160.98 |
| 02/13/08 16:50:56 | 51.78 | 11.06 | 166.18 |
| 02/13/08 16:51:06 | 50.61 | 11.32 | 178.55 |
| 02/13/08 16:51:16 | 49.06 | 11.13 | 198.91 |
| 02/13/08 16:51:26 | 48.78 | 10.60 | 195.89 |
| 02/13/08 16:51:36 | 48.23 | 11.12 | 188.75 |
| 02/13/08 16:51:46 | 49.65 | 11.69 | 166.19 |
| 02/13/08 16:51:56 | 50.85 | 11.96 | 159.49 |
| 02/13/08 16:52:06 | 48.52 | 11.33 | 156.45 |
| 02/13/08 16:52:16 | 46.22 | 10.76 | 164.14 |
| 02/13/08 16:52:26 | 47.34 | 10.63 | 173.26 |
| 02/13/08 16:52:36 | 48.51 | 10.73 | 167.36 |
| 02/13/08 16:52:46 | 49.68 | 10.78 | 150.43 |
| 02/13/08 16:52:56 | 50.56 | 10.25 | 137.92 |
| 02/13/08 16:53:06 | 50.88 | 10.05 | 143.02 |
| 02/13/08 16:53:16 | 51.18 | 10.03 | 150.42 |
| 02/13/08 16:53:26 | 52.99 | 9.92 | 155.88 |
| 02/13/08 16:53:36 | 54.78 | 9.87 | 165.60 |
| 02/13/08 16:53:46 | 54.81 | 9.64 | 172.36 |
| 02/13/08 16:53:56 | 54.73 | 9.11 | 183.11 |
| 02/13/08 16:54:06 | 55.92 | 9.41 | 207.59 |
| 02/13/08 16:54:16 | 56.78 | 9.25 | 209.93 |
| 02/13/08 16:54:26 | 58.00 | 9.25 | 201.32 |
| 02/13/08 16:54:36 | 59.15 | 10.41 | 190.78 |
| 02/13/08 16:54:46 | 58.82 | 10.59 | 173.54 |
| 02/13/08 16:54:56 | 58.84 | 10.34 | 158.85 |
| 02/13/08 16:55:06 | 55.31 | 10.43 | 144.85 |
| 02/13/08 16:55:16 | 52.07 | 10.14 | 138.14 |
| 02/13/08 16:55:26 | 52.97 | 10.36 | 144.23 |
| 02/13/08 16:55:36 | 53.56 | 10.00 | 151.95 |
| 02/13/08 16:55:46 | 53.60 | 9.86 | 162.70 |
| 02/13/08 16:55:56 | 53.59 | 9.46 | 165.89 |
| 02/13/08 16:56:06 | 55.30 | 9.48 | 172.65 |
| 02/13/08 16:56:16 | 57.10 | 9.52 | 163.25 |
| 02/13/08 16:56:26 | 57.65 | 9.87 | 152.21 |
| 02/13/08 16:56:36 | 57.95 | 10.33 | 137.95 |
| 02/13/08 16:56:46 | 57.09 | 9.76 | 131.99 |
| 02/13/08 16:56:56 | 55.92 | 10.18 | 133.18 |
| 02/13/08 16:57:06 | 56.52 | 9.88 | 129.53 |
| 02/13/08 16:57:16 | 56.80 | 9.56 | 128.03 |
| 02/13/08 16:57:26 | 56.50 | 9.91 | 147.77 |
| 02/13/08 16:57:36 | 56.18 | 10.35 | 169.72 |
| 02/13/08 16:57:46 | 55.61 | 10.98 | 175.06 |
| 02/13/08 16:57:56 | 55.03 | 10.98 | 168.30 |
| 02/13/08 16:58:06 | 51.79 | 10.63 | 156.43 |
| 02/13/08 16:58:16 | 48.21 | 10.59 | 149.25 |
| 02/13/08 16:58:26 | 49.05 | 9.96 | 149.87 |
| 02/13/08 16:58:36 | 49.71 | 10.03 | 146.85 |

| | | | |
|-------------------|-------|-------|--------|
| 02/13/08 16:58:46 | 51.76 | 9.85 | 141.82 |
| 02/13/08 16:58:56 | 54.14 | 9.84 | 148.35 |
| 02/13/08 16:59:06 | 54.73 | 10.32 | 164.74 |
| 02/13/08 16:59:16 | 55.31 | 10.34 | 162.67 |
| 02/13/08 16:59:26 | 53.89 | 10.12 | 143.67 |
| 02/13/08 16:59:36 | 52.36 | 10.11 | 132.04 |
| 02/13/08 16:59:46 | 52.70 | 10.35 | 132.65 |
| 02/13/08 16:59:56 | 53.03 | 10.56 | 135.80 |
| 02/13/08 17:00:06 | 52.04 | 11.02 | 145.11 |
| 02/13/08 17:00:16 | 51.21 | 10.81 | 147.44 |
| 02/13/08 17:00:26 | 49.41 | 11.04 | 150.71 |
| 02/13/08 17:00:36 | 47.66 | 11.42 | 146.57 |
| 02/13/08 17:00:46 | 47.66 | 11.69 | 141.52 |
| 02/13/08 17:00:56 | 47.60 | 11.46 | 134.41 |
| 02/13/08 17:01:06 | 46.45 | 11.34 | 137.90 |
| 02/13/08 17:01:16 | 45.53 | 10.53 | 139.96 |
| 02/13/08 17:01:26 | 46.76 | 11.13 | 145.97 |
| 02/13/08 17:01:36 | 48.18 | 11.55 | 147.83 |
| 02/13/08 17:01:46 | 48.50 | 11.34 | 141.50 |
| 02/13/08 17:01:56 | 48.50 | 11.49 | 136.68 |
| 02/13/08 17:02:06 | 47.65 | 11.38 | 132.29 |
| 02/13/08 17:02:16 | 47.05 | 11.01 | 128.97 |
| 02/13/08 17:02:26 | 46.77 | 10.47 | 129.85 |
| 02/13/08 17:02:36 | 46.72 | 10.51 | 156.21 |
| 02/13/08 17:02:46 | 48.79 | 10.24 | 174.46 |
| 02/13/08 17:02:56 | 50.91 | 9.80 | 186.36 |
| 02/13/08 17:03:06 | 51.18 | 9.54 | 204.88 |
| 02/13/08 17:03:16 | 51.51 | 9.51 | 216.49 |
| 02/13/08 17:03:26 | 53.30 | 10.03 | 213.22 |
| 02/13/08 17:03:36 | 55.30 | 10.07 | 198.89 |
| 02/13/08 17:03:46 | 53.87 | 10.42 | 194.09 |
| 02/13/08 17:03:56 | 52.36 | 10.27 | 181.62 |
| 02/13/08 17:04:06 | 51.76 | 10.71 | 170.29 |
| 02/13/08 17:04:16 | 50.86 | 10.86 | 145.42 |
| 02/13/08 17:04:26 | 50.26 | 10.48 | 129.56 |
| 02/13/08 17:04:36 | 49.70 | 10.36 | 126.83 |
| 02/13/08 17:04:46 | 50.62 | 10.40 | 132.30 |
| 02/13/08 17:04:56 | 51.47 | 10.68 | 132.64 |
| 02/13/08 17:05:06 | 51.18 | 10.42 | 134.70 |
| 02/13/08 17:05:16 | 50.85 | 10.48 | 135.58 |
| 02/13/08 17:05:26 | 51.19 | 10.83 | 137.61 |
| 02/13/08 17:05:36 | 51.21 | 10.92 | 136.44 |
| 02/13/08 17:05:46 | 50.02 | 10.55 | 136.71 |
| 02/13/08 17:05:56 | 48.51 | 10.32 | 140.93 |
| 02/13/08 17:06:06 | 49.36 | 10.51 | 147.76 |
| 02/13/08 17:06:16 | 50.03 | 10.40 | 155.89 |
| 02/13/08 17:06:26 | 50.57 | 9.98 | 176.26 |
| 02/13/08 17:06:36 | 51.18 | 9.59 | 174.45 |
| 02/13/08 17:06:46 | 53.02 | 9.79 | 187.29 |
| 02/13/08 17:06:56 | 54.75 | 9.53 | 200.79 |
| 02/13/08 17:07:06 | 54.48 | 9.56 | 220.72 |
| 02/13/08 17:07:16 | 54.18 | 9.84 | 233.89 |
| 02/13/08 17:07:26 | 53.87 | 10.26 | 228.82 |
| 02/13/08 17:07:36 | 53.62 | 10.23 | 199.79 |
| 02/13/08 17:07:46 | 52.34 | 9.90 | 172.10 |
| 02/13/08 17:07:56 | 51.11 | 9.99 | 154.40 |
| 02/13/08 17:08:06 | 52.67 | 9.99 | 151.94 |
| 02/13/08 17:08:16 | 54.42 | 9.78 | 152.64 |

| | | | |
|-------------------|--------------|--------------|---------------|
| 02/13/08 17:08:26 | 53.87 | 10.01 | 152.22 |
| 02/13/08 17:08:36 | 53.60 | 10.17 | 151.92 |
| 02/13/08 17:08:46 | 53.83 | 10.50 | 161.57 |
| 02/13/08 17:08:56 | 53.88 | 10.94 | 169.76 |
| 02/13/08 17:09:06 | 51.42 | 10.90 | 166.22 |
| 02/13/08 17:09:16 | 49.34 | 10.18 | 159.46 |
| AVERAGE > | 52.45 | 10.41 | 160.24 |

Darby Test, Run 2 High Fire

| Date/Time mm/dd/yy hh:mm:ss | NOx ppm | O2 % | CO ppm |
|--------------------------------|------------|---------|-----------|
| 02/13/08 17:32:06 | 60.46 | 8.67 | 184.28 |
| 02/13/08 17:32:16 | 59.85 | 8.59 | 188.42 |
| 02/13/08 17:32:26 | 60.80 | 8.93 | 214.45 |
| 02/13/08 17:32:36 | 61.39 | 9.12 | 232.09 |
| 02/13/08 17:32:46 | 60.47 | 9.32 | 225.54 |
| 02/13/08 17:32:56 | 59.48 | 9.38 | 217.17 |
| 02/13/08 17:33:06 | 58.00 | 8.49 | 240.09 |
| 02/13/08 17:33:16 | 56.18 | 8.45 | 292.84 |
| 02/13/08 17:33:26 | 59.89 | 8.37 | 315.64 |
| 02/13/08 17:33:36 | 63.18 | 9.16 | 315.04 |
| 02/13/08 17:33:46 | 62.55 | 9.49 | 264.50 |
| 02/13/08 17:33:56 | 61.67 | 9.82 | 218.94 |
| 02/13/08 17:34:06 | 59.14 | 9.56 | 182.52 |
| 02/13/08 17:34:16 | 56.77 | 9.66 | 175.92 |
| 02/13/08 17:34:26 | 56.18 | 9.32 | 195.60 |
| 02/13/08 17:34:36 | 55.55 | 9.29 | 232.35 |
| 02/13/08 17:34:46 | 55.29 | 9.14 | 275.22 |
| 02/13/08 17:34:56 | 55.33 | 9.44 | 279.14 |
| 02/13/08 17:35:06 | 56.47 | 9.10 | 258.44 |
| 02/13/08 17:35:16 | 57.64 | 9.56 | 276.78 |
| 02/13/08 17:35:26 | 57.65 | 10.00 | 264.76 |
| 02/13/08 17:35:36 | 57.36 | 9.98 | 228.23 |
| 02/13/08 17:35:46 | 54.95 | 9.79 | 183.08 |
| 02/13/08 17:35:56 | 52.97 | 9.37 | 163.33 |
| 02/13/08 17:36:06 | 53.56 | 8.81 | 178.61 |
| 02/13/08 17:36:16 | 53.85 | 8.89 | 224.10 |
| 02/13/08 17:36:26 | 56.20 | 9.87 | 246.27 |
| 02/13/08 17:36:36 | 58.23 | 9.89 | 332.70 |
| 02/13/08 17:36:46 | 58.26 | 9.91 | 367.05 |
| 02/13/08 17:36:56 | 58.31 | 9.55 | 327.80 |
| 02/13/08 17:37:06 | 55.31 | 9.66 | 284.86 |
| 02/13/08 17:37:16 | 52.72 | 9.81 | 258.14 |
| 02/13/08 17:37:26 | 52.98 | 9.75 | 233.62 |
| 02/13/08 17:37:36 | 53.30 | 9.88 | 210.25 |
| 02/13/08 17:37:46 | 53.02 | 9.51 | 208.20 |
| 02/13/08 17:37:56 | 52.72 | 9.40 | 215.94 |
| 02/13/08 17:38:06 | 53.31 | 9.27 | 206.69 |
| 02/13/08 17:38:16 | 53.91 | 9.40 | 193.52 |
| 02/13/08 17:38:26 | 54.47 | 9.07 | 194.72 |
| 02/13/08 17:38:36 | 55.27 | 9.33 | 223.42 |
| 02/13/08 17:38:46 | 55.92 | 9.80 | 244.36 |
| 02/13/08 17:38:56 | 56.81 | 10.13 | 223.74 |
| 02/13/08 17:39:06 | 54.84 | 9.83 | 195.64 |
| 02/13/08 17:39:16 | 52.38 | 9.79 | 191.13 |
| 02/13/08 17:39:26 | 52.40 | 9.54 | 200.45 |
| 02/13/08 17:39:36 | 52.35 | 9.23 | 207.89 |
| 02/13/08 17:39:46 | 53.85 | 9.14 | 211.17 |
| 02/13/08 17:39:56 | 55.33 | 9.15 | 209.09 |
| 02/13/08 17:40:06 | 55.90 | 9.38 | 203.73 |
| 02/13/08 17:40:16 | 56.50 | 9.29 | 200.48 |
| 02/13/08 17:40:26 | 55.60 | 9.34 | 218.96 |
| 02/13/08 17:40:36 | 55.00 | 9.47 | 237.45 |
| 02/13/08 17:40:46 | 54.75 | 9.68 | 243.21 |

| | | | |
|-------------------|-------|-------|--------|
| 02/13/08 17:40:56 | 54.47 | 9.41 | 232.98 |
| 02/13/08 17:41:06 | 54.23 | 9.42 | 225.27 |
| 02/13/08 17:41:16 | 53.59 | 9.86 | 222.82 |
| 02/13/08 17:41:26 | 54.16 | 10.04 | 210.24 |
| 02/13/08 17:41:36 | 54.53 | 9.50 | 187.92 |
| 02/13/08 17:41:46 | 52.93 | 9.19 | 181.02 |
| 02/13/08 17:41:56 | 51.82 | 8.78 | 215.01 |
| 02/13/08 17:42:06 | 54.76 | 8.64 | 259.98 |
| 02/13/08 17:42:16 | 57.70 | 8.91 | 305.28 |
| 02/13/08 17:42:26 | 58.90 | 9.01 | 307.94 |
| 02/13/08 17:42:36 | 60.17 | 9.28 | 274.35 |
| 02/13/08 17:42:46 | 58.89 | 8.85 | 222.26 |
| 02/13/08 17:42:56 | 57.67 | 8.42 | 211.45 |
| 02/13/08 17:43:06 | 58.85 | 8.72 | 268.93 |
| 02/13/08 17:43:16 | 59.89 | 9.38 | 298.48 |
| 02/13/08 17:43:26 | 59.82 | 9.81 | 274.03 |
| 02/13/08 17:43:36 | 60.16 | 9.64 | 214.68 |
| 02/13/08 17:43:46 | 57.10 | 9.33 | 173.54 |
| 02/13/08 17:43:56 | 54.52 | 9.36 | 161.88 |
| 02/13/08 17:44:06 | 54.95 | 8.96 | 170.36 |
| 02/13/08 17:44:16 | 55.88 | 8.23 | 217.79 |
| 02/13/08 17:44:26 | 57.09 | 8.59 | 318.84 |
| 02/13/08 17:44:36 | 58.54 | 8.74 | 350.84 |
| 02/13/08 17:44:46 | 59.45 | 9.39 | 329.22 |
| 02/13/08 17:44:56 | 60.44 | 9.65 | 271.81 |
| 02/13/08 17:45:06 | 57.39 | 9.56 | 229.69 |
| 02/13/08 17:45:16 | 54.47 | 9.24 | 205.80 |
| 02/13/08 17:45:26 | 55.29 | 9.30 | 210.29 |
| 02/13/08 17:45:36 | 55.90 | 9.36 | 227.69 |
| 02/13/08 17:45:46 | 55.59 | 9.38 | 248.70 |
| 02/13/08 17:45:56 | 55.60 | 9.21 | 254.48 |
| 02/13/08 17:46:06 | 55.34 | 9.35 | 256.28 |
| 02/13/08 17:46:16 | 55.31 | 9.13 | 264.48 |
| 02/13/08 17:46:26 | 55.90 | 9.02 | 268.38 |
| 02/13/08 17:46:36 | 56.47 | 8.87 | 288.13 |
| 02/13/08 17:46:46 | 57.09 | 8.32 | 313.84 |
| 02/13/08 17:46:56 | 57.96 | 8.20 | 342.05 |
| 02/13/08 17:47:06 | 59.85 | 7.98 | 368.25 |
| 02/13/08 17:47:16 | 61.66 | 8.33 | 393.68 |
| 02/13/08 17:47:26 | 62.52 | 8.81 | 374.50 |
| 02/13/08 17:47:36 | 63.45 | 9.12 | 319.87 |
| 02/13/08 17:47:46 | 61.99 | 9.51 | 255.68 |
| 02/13/08 17:47:56 | 60.19 | 10.03 | 211.77 |
| 02/13/08 17:48:06 | 57.61 | 10.33 | 175.94 |
| 02/13/08 17:48:16 | 55.60 | 10.39 | 157.75 |
| 02/13/08 17:48:26 | 53.31 | 10.40 | 148.07 |
| 02/13/08 17:48:36 | 50.90 | 10.40 | 143.37 |
| 02/13/08 17:48:46 | 50.57 | 10.13 | 142.74 |
| 02/13/08 17:48:56 | 50.03 | 9.50 | 149.54 |
| 02/13/08 17:49:06 | 51.51 | 8.96 | 162.98 |
| 02/13/08 17:49:16 | 53.00 | 8.34 | 188.37 |
| 02/13/08 17:49:26 | 56.21 | 8.12 | 217.13 |
| 02/13/08 17:49:36 | 59.89 | 8.83 | 224.97 |
| 02/13/08 17:49:46 | 60.80 | 9.58 | 223.09 |
| 02/13/08 17:49:56 | 61.97 | 10.31 | 194.70 |
| 02/13/08 17:50:06 | 57.67 | 10.04 | 162.11 |
| 02/13/08 17:50:16 | 53.61 | 9.37 | 138.76 |
| 02/13/08 17:50:26 | 53.30 | 9.51 | 141.85 |

| | | | |
|-------------------|-------|-------|--------|
| 02/13/08 17:50:36 | 53.29 | 9.43 | 143.30 |
| 02/13/08 17:50:46 | 53.58 | 9.50 | 148.11 |
| 02/13/08 17:50:56 | 53.84 | 9.59 | 156.76 |
| 02/13/08 17:51:06 | 54.21 | 10.07 | 182.79 |
| 02/13/08 17:51:16 | 54.20 | 10.80 | 184.83 |
| 02/13/08 17:51:26 | 52.07 | 10.86 | 170.36 |
| 02/13/08 17:51:36 | 50.00 | 11.21 | 161.32 |
| 02/13/08 17:51:46 | 48.51 | 10.16 | 172.08 |
| 02/13/08 17:51:56 | 47.01 | 9.73 | 174.21 |
| 02/13/08 17:52:06 | 48.82 | 9.59 | 167.07 |
| 02/13/08 17:52:16 | 50.22 | 9.60 | 181.35 |
| 02/13/08 17:52:26 | 52.67 | 10.41 | 214.44 |
| 02/13/08 17:52:36 | 54.81 | 10.63 | 209.13 |
| 02/13/08 17:52:46 | 51.76 | 10.71 | 178.60 |
| 02/13/08 17:52:56 | 48.82 | 10.77 | 148.10 |
| 02/13/08 17:53:06 | 47.87 | 10.34 | 131.72 |
| 02/13/08 17:53:16 | 46.98 | 10.24 | 129.54 |
| 02/13/08 17:53:26 | 48.21 | 9.79 | 129.88 |
| 02/13/08 17:53:36 | 49.07 | 9.85 | 131.75 |
| 02/13/08 17:53:46 | 50.31 | 10.07 | 140.20 |
| 02/13/08 17:53:56 | 51.21 | 9.78 | 145.98 |
| 02/13/08 17:54:06 | 50.85 | 9.34 | 145.15 |
| 02/13/08 17:54:16 | 50.60 | 9.40 | 139.93 |
| 02/13/08 17:54:26 | 51.79 | 8.89 | 137.27 |
| 02/13/08 17:54:36 | 52.97 | 8.95 | 157.74 |
| 02/13/08 17:54:46 | 54.50 | 8.68 | 169.50 |
| 02/13/08 17:54:56 | 55.89 | 8.67 | 180.67 |
| 02/13/08 17:55:06 | 56.20 | 8.87 | 174.75 |
| 02/13/08 17:55:16 | 56.81 | 9.17 | 162.39 |
| 02/13/08 17:55:26 | 56.18 | 9.29 | 145.37 |
| 02/13/08 17:55:36 | 55.88 | 9.34 | 138.77 |
| 02/13/08 17:55:46 | 54.72 | 9.75 | 129.61 |
| 02/13/08 17:55:56 | 53.59 | 9.44 | 124.51 |
| 02/13/08 17:56:06 | 52.37 | 9.78 | 129.27 |
| 02/13/08 17:56:16 | 51.45 | 9.76 | 130.74 |
| 02/13/08 17:56:26 | 51.19 | 9.56 | 129.83 |
| 02/13/08 17:56:36 | 50.88 | 9.57 | 127.44 |
| 02/13/08 17:56:46 | 51.17 | 9.55 | 132.86 |
| 02/13/08 17:56:56 | 51.45 | 9.83 | 134.64 |
| 02/13/08 17:57:06 | 51.43 | 9.93 | 125.08 |
| 02/13/08 17:57:16 | 51.47 | 9.41 | 112.70 |
| 02/13/08 17:57:26 | 51.19 | 8.81 | 110.69 |
| 02/13/08 17:57:36 | 50.60 | 8.61 | 129.57 |
| 02/13/08 17:57:46 | 53.24 | 9.06 | 166.21 |
| 02/13/08 17:57:56 | 55.66 | 9.60 | 186.37 |
| 02/13/08 17:58:06 | 54.21 | 9.77 | 177.16 |
| 02/13/08 17:58:16 | 53.00 | 9.81 | 153.13 |
| 02/13/08 17:58:26 | 50.84 | 9.93 | 136.16 |
| 02/13/08 17:58:36 | 48.79 | 10.37 | 123.00 |
| 02/13/08 17:58:46 | 49.11 | 10.43 | 116.31 |
| 02/13/08 17:58:56 | 49.10 | 10.30 | 114.51 |
| 02/13/08 17:59:06 | 48.18 | 9.83 | 115.39 |
| 02/13/08 17:59:16 | 47.05 | 9.91 | 122.43 |
| 02/13/08 17:59:26 | 48.79 | 10.31 | 131.77 |
| 02/13/08 17:59:36 | 50.89 | 9.99 | 134.99 |
| 02/13/08 17:59:46 | 49.03 | 9.49 | 139.37 |
| 02/13/08 17:59:56 | 47.64 | 9.03 | 134.38 |
| 02/13/08 18:00:06 | 49.41 | 8.37 | 148.72 |

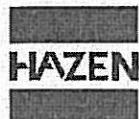
| | | | |
|-------------------|-------|-------|--------|
| 02/13/08 18:00:16 | 51.45 | 8.94 | 183.98 |
| 02/13/08 18:00:26 | 53.64 | 8.73 | 194.68 |
| 02/13/08 18:00:36 | 55.63 | 8.37 | 193.79 |
| 02/13/08 18:00:46 | 55.59 | 8.29 | 190.22 |
| 02/13/08 18:00:56 | 55.62 | 8.29 | 197.75 |
| 02/13/08 18:01:06 | 56.82 | 9.08 | 197.40 |
| 02/13/08 18:01:16 | 58.02 | 9.50 | 176.59 |
| 02/13/08 18:01:26 | 56.25 | 9.92 | 143.41 |
| 02/13/08 18:01:36 | 54.17 | 9.94 | 123.87 |
| 02/13/08 18:01:46 | 51.45 | 9.75 | 128.66 |
| 02/13/08 18:01:56 | 49.13 | 10.10 | 145.37 |
| 02/13/08 18:02:06 | 49.34 | 10.49 | 147.43 |
| 02/13/08 18:02:16 | 49.97 | 10.66 | 137.63 |
| 02/13/08 18:02:26 | 48.47 | 10.56 | 125.92 |
| 02/13/08 18:02:36 | 47.02 | 10.14 | 120.88 |
| 02/13/08 18:02:46 | 46.76 | 10.26 | 127.46 |
| 02/13/08 18:02:56 | 46.41 | 10.08 | 126.59 |
| 02/13/08 18:03:06 | 47.60 | 10.42 | 126.26 |
| 02/13/08 18:03:16 | 48.49 | 10.09 | 120.94 |
| 02/13/08 18:03:26 | 48.51 | 10.30 | 124.20 |
| 02/13/08 18:03:36 | 48.50 | 11.00 | 128.66 |
| 02/13/08 18:03:46 | 47.65 | 10.24 | 127.72 |
| 02/13/08 18:03:56 | 46.77 | 9.98 | 127.14 |
| 02/13/08 18:04:06 | 47.91 | 10.05 | 136.43 |
| 02/13/08 18:04:16 | 49.40 | 9.68 | 135.83 |
| 02/13/08 18:04:26 | 49.38 | 9.64 | 147.21 |
| 02/13/08 18:04:36 | 49.67 | 9.36 | 146.04 |
| 02/13/08 18:04:46 | 49.71 | 9.33 | 162.35 |
| 02/13/08 18:04:56 | 50.03 | 9.57 | 172.98 |
| 02/13/08 18:05:06 | 50.88 | 10.22 | 169.21 |
| 02/13/08 18:05:16 | 52.09 | 10.06 | 158.00 |
| 02/13/08 18:05:26 | 49.41 | 10.04 | 147.75 |
| 02/13/08 18:05:36 | 46.72 | 9.86 | 145.69 |
| 02/13/08 18:05:46 | 48.25 | 9.84 | 145.14 |
| 02/13/08 18:05:56 | 49.38 | 9.55 | 139.66 |
| 02/13/08 18:06:06 | 49.99 | 9.45 | 132.30 |
| 02/13/08 18:06:16 | 50.56 | 9.89 | 131.07 |
| 02/13/08 18:06:26 | 50.91 | 9.64 | 131.73 |
| 02/13/08 18:06:36 | 50.91 | 9.49 | 146.26 |
| 02/13/08 18:06:46 | 50.90 | 9.47 | 146.54 |
| 02/13/08 18:06:56 | 50.90 | 9.72 | 183.94 |
| 02/13/08 18:07:06 | 52.39 | 10.13 | 188.76 |
| 02/13/08 18:07:16 | 53.92 | 10.54 | 175.63 |
| 02/13/08 18:07:26 | 50.28 | 10.42 | 150.46 |
| 02/13/08 18:07:36 | 46.68 | 10.40 | 134.38 |
| 02/13/08 18:07:46 | 45.85 | 10.67 | 123.29 |
| 02/13/08 18:07:56 | 44.68 | 10.53 | 120.59 |
| 02/13/08 18:08:06 | 44.43 | 10.36 | 123.91 |
| 02/13/08 18:08:16 | 44.10 | 9.92 | 121.87 |
| 02/13/08 18:08:26 | 45.55 | 9.64 | 116.55 |
| 02/13/08 18:08:36 | 47.05 | 9.83 | 112.99 |
| 02/13/08 18:08:46 | 48.49 | 9.61 | 114.22 |
| 02/13/08 18:08:56 | 50.02 | 9.71 | 121.49 |
| 02/13/08 18:09:06 | 50.02 | 9.58 | 132.65 |
| 02/13/08 18:09:16 | 50.05 | 9.50 | 138.17 |
| 02/13/08 18:09:26 | 50.57 | 9.82 | 143.95 |
| 02/13/08 18:09:36 | 51.17 | 10.06 | 141.82 |
| 02/13/08 18:09:46 | 49.70 | 10.06 | 136.43 |

| | | | |
|-------------------|-------|-------|--------|
| 02/13/08 18:09:56 | 48.49 | 9.78 | 133.23 |
| 02/13/08 18:10:06 | 47.94 | 9.80 | 129.58 |
| 02/13/08 18:10:16 | 47.33 | 10.16 | 126.60 |
| 02/13/08 18:10:26 | 47.60 | 9.67 | 123.56 |
| 02/13/08 18:10:36 | 47.91 | 9.45 | 132.66 |
| 02/13/08 18:10:46 | 48.79 | 9.10 | 146.59 |
| 02/13/08 18:10:56 | 49.44 | 8.80 | 155.00 |
| 02/13/08 18:11:06 | 51.23 | 8.81 | 178.84 |
| 02/13/08 18:11:16 | 53.00 | 9.08 | 188.75 |
| 02/13/08 18:11:26 | 53.56 | 8.99 | 175.63 |
| 02/13/08 18:11:36 | 54.22 | 9.10 | 160.12 |
| 02/13/08 18:11:46 | 54.17 | 9.11 | 159.47 |
| 02/13/08 18:11:56 | 54.21 | 9.27 | 159.20 |
| 02/13/08 18:12:06 | 53.32 | 8.70 | 158.56 |
| 02/13/08 18:12:16 | 52.35 | 8.37 | 181.35 |
| 02/13/08 18:12:26 | 54.18 | 8.30 | 206.40 |
| 02/13/08 18:12:36 | 55.96 | 8.82 | 212.72 |
| 02/13/08 18:12:46 | 56.24 | 8.87 | 202.23 |
| 02/13/08 18:12:56 | 56.54 | 8.50 | 191.14 |
| 02/13/08 18:13:06 | 55.91 | 8.44 | 204.91 |
| 02/13/08 18:13:16 | 55.02 | 8.95 | 224.07 |
| 02/13/08 18:13:26 | 55.92 | 9.33 | 221.00 |
| 02/13/08 18:13:36 | 56.79 | 10.07 | 200.39 |
| 02/13/08 18:13:46 | 53.60 | 10.34 | 168.84 |
| 02/13/08 18:13:56 | 50.29 | 9.92 | 139.97 |
| 02/13/08 18:14:06 | 49.41 | 10.00 | 123.60 |
| 02/13/08 18:14:16 | 48.50 | 9.79 | 124.47 |
| 02/13/08 18:14:26 | 49.01 | 9.62 | 136.44 |
| 02/13/08 18:14:36 | 49.40 | 9.76 | 138.48 |
| 02/13/08 18:14:46 | 49.97 | 9.41 | 133.51 |
| 02/13/08 18:14:56 | 50.27 | 8.92 | 137.94 |
| 02/13/08 18:15:06 | 51.44 | 8.54 | 155.59 |
| 02/13/08 18:15:16 | 52.64 | 8.21 | 184.54 |
| 02/13/08 18:15:26 | 54.78 | 8.54 | 216.87 |
| 02/13/08 18:15:36 | 57.09 | 9.09 | 249.61 |
| 02/13/08 18:15:46 | 56.48 | 9.30 | 236.30 |
| 02/13/08 18:15:56 | 56.20 | 9.74 | 196.54 |
| 02/13/08 18:16:06 | 54.41 | 9.83 | 157.98 |
| 02/13/08 18:16:16 | 53.00 | 10.18 | 144.86 |
| 02/13/08 18:16:26 | 51.43 | 9.48 | 139.64 |
| 02/13/08 18:16:36 | 49.96 | 9.51 | 144.26 |
| 02/13/08 18:16:46 | 51.49 | 9.66 | 139.06 |
| 02/13/08 18:16:56 | 53.02 | 10.06 | 135.61 |
| 02/13/08 18:17:06 | 52.03 | 10.15 | 135.55 |
| 02/13/08 18:17:16 | 50.92 | 10.34 | 142.70 |
| 02/13/08 18:17:26 | 49.65 | 10.57 | 150.75 |
| 02/13/08 18:17:36 | 48.14 | 10.16 | 154.69 |
| 02/13/08 18:17:46 | 47.04 | 10.09 | 157.41 |
| 02/13/08 18:17:56 | 45.85 | 9.48 | 146.86 |
| 02/13/08 18:18:06 | 48.17 | 9.51 | 142.73 |
| 02/13/08 18:18:16 | 50.86 | 9.61 | 139.95 |
| 02/13/08 18:18:26 | 52.72 | 9.34 | 133.75 |
| 02/13/08 18:18:36 | 54.45 | 9.07 | 136.43 |
| 02/13/08 18:18:46 | 54.74 | 9.52 | 141.20 |
| 02/13/08 18:18:56 | 55.27 | 9.68 | 138.76 |
| 02/13/08 18:19:06 | 54.14 | 9.79 | 136.14 |
| 02/13/08 18:19:16 | 53.00 | 9.88 | 133.19 |
| 02/13/08 18:19:26 | 52.35 | 10.18 | 128.35 |

| | | | |
|-------------------|-------|-------|--------|
| 02/13/08 18:19:36 | 51.42 | 9.96 | 119.39 |
| 02/13/08 18:19:46 | 50.54 | 9.87 | 110.99 |
| 02/13/08 18:19:56 | 49.70 | 9.78 | 110.09 |
| 02/13/08 18:20:06 | 50.57 | 9.70 | 120.88 |
| 02/13/08 18:20:16 | 51.47 | 9.91 | 131.12 |
| 02/13/08 18:20:26 | 52.07 | 9.89 | 132.32 |
| 02/13/08 18:20:36 | 52.69 | 10.02 | 128.03 |
| 02/13/08 18:20:46 | 51.73 | 10.30 | 128.69 |
| 02/13/08 18:20:56 | 51.18 | 10.48 | 129.26 |
| 02/13/08 18:21:06 | 50.25 | 10.66 | 128.08 |
| 02/13/08 18:21:16 | 49.40 | 10.77 | 126.29 |
| 02/13/08 18:21:26 | 48.48 | 10.69 | 125.36 |
| 02/13/08 18:21:36 | 47.89 | 10.38 | 130.48 |
| 02/13/08 18:21:46 | 47.91 | 10.85 | 137.02 |
| 02/13/08 18:21:56 | 47.87 | 10.34 | 149.24 |
| 02/13/08 18:22:06 | 48.17 | 10.35 | 198.88 |
| 02/13/08 18:22:16 | 48.13 | 10.27 | 200.50 |
| 02/13/08 18:22:26 | 49.08 | 9.81 | 180.42 |
| 02/13/08 18:22:36 | 49.96 | 9.10 | 167.97 |
| 02/13/08 18:22:46 | 51.72 | 8.79 | 165.01 |
| 02/13/08 18:22:56 | 53.55 | 8.84 | 170.98 |
| 02/13/08 18:23:06 | 55.89 | 8.90 | 174.47 |
| 02/13/08 18:23:16 | 58.22 | 9.76 | 188.76 |
| 02/13/08 18:23:26 | 57.65 | 10.15 | 190.21 |
| 02/13/08 18:23:36 | 57.10 | 9.97 | 178.63 |
| 02/13/08 18:23:46 | 54.16 | 10.14 | 168.27 |
| 02/13/08 18:23:56 | 51.10 | 9.81 | 163.92 |
| 02/13/08 18:24:06 | 50.84 | 9.86 | 161.01 |
| 02/13/08 18:24:16 | 50.56 | 9.97 | 155.93 |
| 02/13/08 18:24:26 | 51.42 | 10.10 | 157.08 |
| 02/13/08 18:24:36 | 52.03 | 10.34 | 163.86 |
| 02/13/08 18:24:46 | 51.44 | 10.79 | 174.45 |
| 02/13/08 18:24:56 | 50.57 | 10.73 | 177.77 |
| 02/13/08 18:25:06 | 49.08 | 9.71 | 168.26 |
| 02/13/08 18:25:16 | 47.27 | 9.87 | 165.62 |
| 02/13/08 18:25:26 | 49.94 | 10.03 | 156.23 |
| 02/13/08 18:25:36 | 52.65 | 9.83 | 150.77 |
| 02/13/08 18:25:46 | 51.71 | 9.42 | 155.57 |
| 02/13/08 18:25:56 | 50.80 | 8.95 | 164.44 |
| 02/13/08 18:26:06 | 53.28 | 9.19 | 186.10 |
| 02/13/08 18:26:16 | 55.29 | 9.77 | 204.27 |
| 02/13/08 18:26:26 | 55.60 | 9.99 | 196.19 |
| 02/13/08 18:26:36 | 55.57 | 10.36 | 188.13 |
| 02/13/08 18:26:46 | 54.45 | 10.54 | 175.63 |
| 02/13/08 18:26:56 | 53.23 | 10.68 | 170.39 |
| 02/13/08 18:27:06 | 52.00 | 10.38 | 156.78 |
| 02/13/08 18:27:16 | 50.54 | 10.08 | 144.86 |
| 02/13/08 18:27:26 | 50.59 | 10.23 | 132.92 |
| 02/13/08 18:27:36 | 50.53 | 10.57 | 127.15 |
| 02/13/08 18:27:46 | 50.24 | 10.71 | 122.37 |
| 02/13/08 18:27:56 | 49.97 | 10.48 | 125.71 |
| 02/13/08 18:28:06 | 49.68 | 10.28 | 122.14 |
| 02/13/08 18:28:16 | 49.05 | 10.41 | 113.03 |
| 02/13/08 18:28:26 | 50.22 | 9.74 | 105.52 |
| 02/13/08 18:28:36 | 51.46 | 10.00 | 112.11 |
| 02/13/08 18:28:46 | 53.55 | 9.58 | 130.78 |
| 02/13/08 18:28:56 | 55.88 | 9.91 | 162.98 |
| 02/13/08 18:29:06 | 56.47 | 10.11 | 161.34 |

| | | | |
|-------------------|--------------|-------------|---------------|
| 02/13/08 18:29:16 | 57.05 | 10.36 | 148.07 |
| 02/13/08 18:29:26 | 54.48 | 10.24 | 136.13 |
| 02/13/08 18:29:36 | 52.00 | 10.81 | 134.39 |
| 02/13/08 18:29:46 | 51.75 | 11.20 | 137.04 |
| 02/13/08 18:29:56 | 51.45 | 11.63 | 138.49 |
| 02/13/08 18:30:06 | 48.75 | 12.01 | 138.76 |
| 02/13/08 18:30:16 | 46.38 | 11.64 | 138.12 |
| 02/13/08 18:30:26 | 44.93 | 11.16 | 138.49 |
| 02/13/08 18:30:36 | 43.75 | 10.44 | 130.45 |
| 02/13/08 18:30:46 | 45.50 | 10.14 | 126.00 |
| 02/13/08 18:30:56 | 47.88 | 9.97 | 131.45 |
| 02/13/08 18:31:06 | 49.31 | 9.89 | 138.44 |
| 02/13/08 18:31:16 | 51.13 | 9.58 | 141.54 |
| 02/13/08 18:31:26 | 52.39 | 9.69 | 140.95 |
| 02/13/08 18:31:36 | 53.25 | 10.26 | 145.39 |
| 02/13/08 18:31:46 | 52.97 | 10.36 | 147.46 |
| 02/13/08 18:31:56 | 52.66 | 10.70 | 143.08 |
| 02/13/08 18:32:06 | 51.15 | 10.91 | 135.59 |
| 02/13/08 18:32:16 | 49.34 | 11.11 | 140.64 |
| 02/13/08 18:32:26 | 48.53 | 11.36 | 143.95 |
| AVERAGE > | 52.83 | 9.67 | 176.05 |

APPENDIX E:
FUEL ANALYSIS

**Hazen Research, Inc.**

4601 Indiana Street
Golden, CO 80403 USA
Tel: (303) 279-4501
Fax: (303) 278-1528

Date March 13 2008
HRI Project 002-WNO
HRI Series No. B250/08-2
Date Rec'd. 02/27/08
Cust. P.O.#

Bison Engineering, Inc.
Jim Wollenberg
1400 11th Avenue
Helena, MT 59601

Sample Identification
Victor and Darby

Reporting
Basis >

As Rec'd

Dry

Air Dry

Proximate (%)

| | | | |
|------------------|--------|--------|--------|
| Moisture | 46.28 | 0.00 | 5.99 |
| Ash | 0.33 | 0.61 | 0.57 |
| Volatile | 46.10 | 85.82 | 80.68 |
| Fixed C | 7.29 | 13.57 | 12.76 |
| Total | 100.00 | 100.00 | 100.00 |
| Sulfur | 0.05 | 0.09 | 0.08 |
| Btu/lb (HHV) | 4675 | 8703 | 8182 |
| MMF Btu/lb | 4691 | 8761 | |
| MAF Btu/lb | | 8757 | |
| Air Dry Loss (%) | | 42.86 | |

Ultimate (%)

| | | | |
|----------|--------|--------|--------|
| Moisture | 46.28 | 0.00 | 5.99 |
| Carbon | 28.20 | 52.49 | 49.35 |
| Hydrogen | 3.01 | 5.59 | 5.26 |
| Nitrogen | 0.03 | 0.05 | 0.05 |
| Sulfur | 0.05 | 0.09 | 0.08 |
| Ash | 0.33 | 0.61 | 0.57 |
| Oxygen* | 22.10 | 41.17 | 38.70 |
| Total | 100.00 | 100.00 | 100.00 |

Chlorine**

Forms of Sulfur (as S,%)

| | |
|---------|------|
| Sulfate | |
| Pyritic | |
| Organic | — |
| Total | 0.05 |

Water Soluble Alkalies (%)

Na20
K20

Lb. Alkali/MM Btu=
Lb. Ash/MM Btu= 0.70
Lb. SO2/MM Btu= 0.20
HGI= @ % Moisture
As Rec'd. Sp.Gr.=
Free Swelling Index=
F-Factor(dry), DSCF/MM BTU= 9,399

Report Prepared By:

Gerald H. Cunningham
Fuels Laboratory Supervisor

* Oxygen by Difference.

** Not usually reported as part of the ultimate analysis.

APPENDIX F:
NOMENCLATURE AND FORMULAE

Nomenclature

| | | | |
|-------------------|--|----------------------|---|
| A_n | sampling nozzle cross-sectional area , ft ² | $C_{X(\text{corr})}$ | actual gas concentration corrected to required percent O ₂ |
| A_s | stack cross-sectional area, ft ² <i>Note: Method 2 refers to this as A</i> | D_{50} | diameter of particles having a 50 percent probability of penetration, μm |
| a | mean particle projected area | D_e | equivalent diameter |
| Btu | unit heat value (British thermal unit) | D_h | hydraulic diameter |
| B_{win} | percent moisture in gas at meter | $DH_{@}$ | pressure drop across orifice meter for 0.75 CFM at standard conditions |
| B_{ws} | percent moisture in stack gas | DH | pressure drop across orifice meter |
| C_1 | viscosity constant, 51.12 micropoise for K (51.05 micropoise for °R) | D_n | source sampling nozzle diameter |
| C_2 | viscosity constant, 0.372 micropoise/K (0.207 micropoise/°R) | D_{p50} | 50% effective cutoff diameter of particle, μ |
| C_3 | viscosity constant, 1.05×10^{-4} micropoise/K ² (3.24×10^{-5} micropoise/°R ²) | D_s | diameter of the stack, feet |
| C_4 | viscosity constant, 53.147 micropoise/ fraction O ₂ | E | emission rate or mass/unit heat (Btu input) |
| C_5 | viscosity constant, 74.143 micropoise/ fraction H ₂ O | e | base of natural logarithms ($\ln 10 = 2.302585$) |
| C_a | concentration of acetone blank residue, mg/g | %EA | percent excess air |
| C_{cond} | concentration of condensibles, grain/dscf | E_{hr} | emission rate per hour, lb/hr |
| C_{cors} | concentration of coarse particulate, gr/dscf | ER _{cond} | emission rate of condensibles, lb/hr |
| C_p | pitot tube calibration coefficient, 0.84 for type S pitot tube | ER _{cors} | emission rate of coarse particulate, lb/hr |
| Cp(std) | standard pitot-static tube calibration coefficient | ER _{mmBtu} | emission rate per mmBtu or ton of fuel, etc. |
| $C_{\text{PM}10}$ | concentration of PM ₁₀ particulate, gr/dscf | ER _{PM10} | emission rate of PM ₁₀ particulate, lb/hr |
| C_s | particulate concentration in stack gas, mass/volume | ER _x | emission rate of compound which replaces x |
| cs12 | particulate concentration corrected to 12 percent CO ₂ | F _c | F factor for CO ₂ , used with percent CO ₂ , wet or dry basis |
| c_{s50} | particulate concentration corrected to 50 percent excess air | F _d | F factor for dry effluent, used with percent O ₂ , dry basis |
| cws | particulate concentration on a wet basis, mass/wet volume | f _o | stack gas fraction O ₂ , by volume, dry basis |
| | | F _o | fuel factor |
| | | F _w | F factor for wet effluent, used with percent O ₂ , wet basis |
| | | ΔH | average pressure differential across orifice meter at control box |
| | | ΔH _@ | orifice pressure, inches H ₂ O |

| | | | |
|----------------------|---|----------------------|---|
| ΔH_d | orifice pressure head, inches H ₂ O, needed for cyclone flow rate | n | number of particles |
| %I | percent sampling rate variation, where 100% = ideal isokinetic conditions | N _{re} | Reynolds Number |
| j | equal area centroid | θ | total sampling time, min. |
| K ₁ | 0.001333 m ³ /ml for metric units 01.1 ft ³ /ml for English units <i>Equation 4-1</i> | O ₁ | plume opacity at exit |
| K ₂ | 0.001335 m ³ /g for metric units 1. ft ³ /g for English units <i>Equation 4-2</i> | O ₂ | in-stack plume opacity |
| K ₃ | 0.3858 °K/mm Hg for metric units 1. °R/in. Hg for English units <i>Equation 4-3</i> | ΔP | stack differential pressure recorded by the probe's type S pitot tube |
| K _p | pitot tube equation dimensional constant, 85.49 | Δp | velocity head of stack gas, mm H ₂ O (in. H ₂ O) - <i>Equation 2-8</i> |
| L | length of duct cross-section at sampling site | $\sqrt{\Delta P}$ | average of the square roots of ΔP (may also be referred to as AS ΔP) |
| L ₁ | plume exit diameter | $\sqrt{\Delta P_1}$ | square root of ΔP at point 1 of the current test |
| L ₂ | stack diameter | $\sqrt{\Delta P_1'}$ | square root of ΔP at point 1 of the previous traverse |
| m | mass | $\sqrt{\Delta P'}$ | average of the square roots of ΔP from the previous traverse (may also be referred to as AS $\Delta P'$) |
| M _a | acetone residue weight after evaporation, mg | %CO ₂ | percent CO ₂ by volume, dry basis |
| mBtu | thousand Btu | %O ₂ | percent O ₂ by volume, dry basis |
| M _{cond} | mass of condensibles | %CO | percent CO by volume, dry basis |
| M _{coars} | mass of coarse particulate | %N ₂ | percent N ₂ by volume, dry basis |
| M _d | dry stack gas molecular weight | P _{atm} | atmospheric pressure |
| m _f | filter weight gain, mg | P _b | barometric pressure (P _b = P _{atm}) |
| M _{fine} | mass of PM ₁₀ particulate | P _{bar} | barometric pressure at measurement site, mm Hg (in. Hg) |
| mmBtu | million Btu | P _g | stack static pressure, mm Hg (in. Hg) |
| m _n | total weight of collected particulate, mg | P _i | pitch angle at traverse point i, degree |
| m _{u, pm10} | total weight of collected PM ₁₀ particulate, mg | P _m | absolute pressure at the meter |
| M _s | wet stack gas molecular weight | pmr | pollutant mass rate |
| M _w | molecular weight of water, 18.0 g/g-mole (18.0 lb/lb-mole) | P _p | absolute barometric pressure at the sample location, inches Hg |
| M _{wx} | molecular weight of gas species, g/gmol | P _s | absolute pressure in the stack |

| | | | |
|--------------|---|---------------|--|
| P_{std} | standard absolute pressure, 760 mm Hg (29.92 in. Hg) | V_i | initial volume, if any, of condenser water, ml |
| pts | number of traverse points during the test, minimum of 6, maximum of 12 | V_m | dry gas volume measured by dry gas meter, dcm (dcf) |
| ρ_w | density of water, 0.9982 g/ml (0.002201 lb/ml) | ΔV_m | incremental dry gas volume measured by dry gas meter at each traverse point, dcm (dcf) |
| q | time in minutes | V_{max} | maximum allowed nozzle velocity , fps |
| Q_a | stack gas volumetric flow rate, acfm | V_{min} | minimum allowed nozzle velocity, fps |
| Q_s | average stack gas wet volumetric flow rate, cfm (ft ³ /min) | $V_{m(std)}$ | dry gas volume measured by the dry gas meter, corrected to standard conditions, dscm (dscf) |
| Q_{sc} | actual gas flow rate through the cyclone, acfm | V_n | target nozzle velocity, fps |
| Q_{sc}' | predicted actual gas flow rate through the cyclone, acfm | v_s | average stack gas velocity, m/sec (ft/sec) |
| $Q_{s(std)}$ | total cyclone flow rate at standard conditions, dscm/min (dscf/ min) | V_w | volume of water vapor |
| Q_{std} | dry volumetric stack gas flow rate corrected to standard conditions | $V_{w(std)}$ | volume of water vapor in the gas sample, corrected to standard conditions, scf (standard cubic feet) |
| Q_w | wet stack gas standard volumetric flow, ft ³ /min, wscfm | $V_{wc(std)}$ | volume of water vapor condensed corrected to standard conditions, scm (scf) |
| r | path length | $V_{ws(std)}$ | volume of water vapor collected in silica gel corrected to standard conditions, scm (scf) |
| R | ideal gas constant, 0.06236 (mm Hg) (m ³)/(g-mole) (K) for metric units and 21.85 (in. Hg) (ft ³)/(lb-mole) ($^{\circ}$ R) for English units | Volume | metric units = 0.00134 m ³ /ml x ml H ₂ O H ₂ O English units = 0.04707 ft ³ /mlxmlH ₂ O |
| R_i | resultant angle at traverse point i, degree | W | width of the duct cross-section at the sampling site |
| R_{max} | multiplier for V_u | W_f | final weight of silica gel or silica gel plus impinger, g |
| R_{min} | multiplier for V_u | W_i | initial weight of silica gel or silica gel plus impinger, g |
| T_m | absolute temperature at meter, K ($^{\circ}$ R) | W_{lc} | weight of collected water, g |
| t_s | stack temperature, $^{\circ}$ C ($^{\circ}$ F) | X_d | fraction of dry gas |
| T_s | absolute stack temperature, K ($^{\circ}$ R) | Y | dry gas meter calibration factor |
| $T_{s(avg)}$ | average stack gas temperature, absolute, $^{\circ}$ R | Y_i | yaw angle at traverse point i, degree 0.280 molecular weight of N ₂ or CO divided by 100 |
| T_{std} | standard absolute temperature, 293 K (528 $^{\circ}$ R) | 1. | molecular weight of O ₂ divided by 100 |
| T_t | duration of test | | |
| μ_s | stack gas absolute viscosity, μ poise | | |
| V_f | final volume of condenser water, ml | | |

0.440 molecular weight of CO₂ divided by 100

18.0 molecular weight of water, g/g-mole
(lb/lb-mole)

3,600 conversion factor, sec/hr

Subscripts:

atm atmospheric

ave average

b barometric

d dry gas basis

f final

g gauge

i initial

m at meter

n at nozzle

p of pitot tube

s at stack

SCF standard cubic feet

std standard conditions

w wet basis

FORMULAE

1. Dry Gas Volume - Corrected to STP (40 CFR 60, App. A, Eq. 5-1)

$$V_{m(std)} = V_m Y \left(\frac{T_{std}}{T_m} \right) \left[\frac{P_{b_{ar}} + \frac{\Delta H}{13.6}}{P_{std}} \right]$$

Y is obtained from post-test meter calibrations.

2. Water Vapor Volume - Corrected to STP (40 CFR 60, App. A, Eq. 5-2)

$$V_{w(std)} = V_{lc} \left(\frac{\rho_w}{M_w} \right) \left(\frac{RT_{std}}{P_{std}} \right)$$

Note: $W_{lc} = V_{lc} \rho_w$

3. Stack Gas Moisture Content (40 CFR 60 App. A, Eq. 5-3, modified)

$$B_{ws} = \frac{V_{w(std)}}{V_{m(std)} + V_{w(std)}}$$

4. Stack Gas Dry and Wet Molecular Weight (40 CFR 60 App. A, Eq. 3-1, 2-5)

$$M_d = 0.440(\%CO_2) + 0.320(\%O_2) + 0.280(\%N_2 + \%CO)$$

$$M_s = M_d (1 - B_{ws}) + 18.0 B_{ws}$$

5. Average Stack Gas Velocity (40 CFR 60 App. A, Eq. 2-9)

$$v_s = K_p C_p \left(\frac{\sum_{i=1}^n \sqrt{\Delta p_i}}{n} \right) \sqrt{\frac{T_{s(\text{avg})}}{P_s M_s}}$$

6. Average Stack Gas Wet Volumetric Flow Rate

$$Q_s = 60 v_s A_s$$

7. Average Stack Gas Dry Flow Rate Corrected to Standard Conditions (40 CFR 60 App. A, Eq. 2-10, modified)

$$Q_{std} = Q_s (1 - B_{ws}) \frac{T_{std}}{T_{s(\text{avg})}} \frac{P_s}{P_{std}}$$

8. TSP Particulate Concentration Corrected to Standard Conditions (40 CFR 60 App. A, Eq. 5-6, modified)

$$c_{s_{lb}} = 2.205 \times 10^{-6} \frac{m_n}{V_{m(std)}}$$

$$c_{s_{gr}} = 15.43 \times 10^{-3} \frac{m_n}{V_{m(std)}}$$

Note: $C_{s,lb}$ = lb/dscf
 $C_{s,gr}$ = grains/dscf
 m_n = mg

9. TSP Emission Rate per Hour

$$E_{hr} = c_s Q_{std} 60$$

10. Percent Isokinetic Sampling Variation (40 CFR 60 App. A, Eq. 5-8)

$$I\% = \frac{T_{s(avg)} V_{m(std)} P_{std} 100}{T_{std} v_s \Theta A_n P_s 60 (1 - B_{ws})}$$

11. Percent moisture at 100 percent saturation (%SVP) equation:

$$\% SVP = \left[\frac{100}{P_s} \right] \times 10^{\left[6.6911 - \frac{3144}{(T_{ws} - 390.86)} \right]}$$

where: P_s = stack pressure (absolute), inches of mercury
 T_{ws} = saturated stack temperature, degrees F

12. Emission Rate Compressor Engines (g/BHP-Hr)

$$E = \frac{(e) PPM Q_{STD}}{BHP}$$

13. Brake Horsepower for Compressor Engines

$$BHP = [43.6 \times MMCFD \times \left(\frac{T_{ts}}{T_{std2}} \right) \times \left(\frac{K}{(K-1)} \right) \times \left(R_2^{\frac{(k-1)}{k}} - 1 \right) \times LE \times FE] + Fan HP$$

14. Pounds Per Hour Emission Rate

$$lb/hr = E * BHP * \frac{lb}{453.59 g}$$

15. Analyzer Calibration error, in general, % diff. $\leq 2\%$

$$\% Diff. = \left(\frac{Cal. gas ppm - Analyzer response ppm}{Analyzer span ppm} \right) \times 100$$

16. System bias, in general < 5% for both zero and upscale gases

$$\text{system Bias} = \left(\frac{\text{system cal. response ppm} - \text{Analyzer response ppm}}{\text{span gas ppm}} \right) \times 100$$

17. Calibration drift < 3% for both zero and upscale gases during each run

$$\text{Cal. Drift} = \left(\frac{\text{final sys Cal. resp. ppm} - \text{initial sys cal. resp. ppm}}{\text{span gas ppm}} \right) \times 100$$

- 18.

$$\text{System Calibration Bias} = \left(\frac{\text{System Cal. Response ppm} - \text{Analyzer Cal. Response ppm}}{\text{span gas ppm}} \right) \times 100$$

- 19.

$$\text{Drift} = \left(\frac{\text{Final System Cal. Response ppm} - \text{Initial System Cal. Response ppm}}{\text{Span gas ppm}} \right) \times 100$$

20. Analyzer calibration error, in general, %diff. ≤ 2%

$$\% \text{ Diff.} = \left(\frac{\text{Cylinder ppm} - \text{analyzer response ppm}}{\text{span gas ppm}} \right) \times 100$$

21. Parts per million by volume (ppmv) to pounds per hour (lbs/hr)

$$\text{lbs/hr} = 1.558 \times 10^{-7} \times \text{molecular weight} \times \text{flow, dscfm} \times \text{ppmv}$$

$$\text{lbs/hr} = (\text{ppmv}) (1.558 \times 10^{-7}) (\text{MW}) (\text{dscfm})$$

ppm = parts per million

dscfm = dry standard cubic feet per minute

MW = molecular weight

22. Corrected concentrations to 12% CO₂

$$Cs_{12} = Cs \frac{12}{\% \text{CO}_2}$$

23. Correcting concentrations to 6% O₂

$$Cs_{\%O_2d} = Cs \left[\frac{20.9 - 6 \%O_2}{20.9 - \%O_{2d}} \right]$$

24. Concentration moisture corrections

$$Cd = (Cw) / (1 - Bws)$$

Cd = concentration dry

Cw = concentration wet

Bws = moisture content

25. Fuel Burning Rule

Fuel Input: Measure fuel introduced to the boiler bank. For example,

$$E = 0.882 * H^{-0.1664}$$

$$E = 0.882 (12,500 \text{ lb}_{\text{fuel}}/\text{hr} \times 4800 \text{ Btu/lb}_{\text{fuel}}) / (1 \times 10^6)^{-0.1664}$$

$$E = 0.882 (60 \text{ MMBtu/hr})^{-0.1664}$$

$$E = 0.4463 \text{ lb/MMBtu}$$

Where E is the maximum allowable particulate emissions rate in lbs per MMBtu.

Steam Production: Measure steam produced by the boiler bank. For example,

$$E = 0.882 * H^{-0.1664}$$

$$E = 0.882 [(30,000 \text{ lb}_{\text{steam}}/\text{hr} \times 1,200 \text{ Btu/lb}_{\text{steam}}) / (60\%_{\text{boiler}} \text{ efficiency})] / (1 \times 10^6)^{-0.1664}$$

$$E = 0.882 (60 \text{ MMBtu/hr})^{-0.1664}$$

$$E = 0.4463 \text{ lb/MMBtu}$$

Where E is the maximum allowable particulate emissions rate in lbs per MMBtu.